

Geochemical characterization of basement aquifers within the Limpopo Province, South Africa

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GEOCHEMICAL CHARACTERISTICS OF BASEMENT AQUIFERS WITHIN THE LIMPOPO PROVINCE, SOUTH AFRICA

ABSTRACT

Precambrian crystalline basement rocks occur extensively in the northern part of South Africa and make up more than 40% of the total bedrock geology of Africa. It is important therefore to understand the aquifer systems associated with these basement rocks since they supply sustainable groundwater to many communities. Most of the water supply in the Limpopo Province, South Africa is groundwater reliant. A Water Research Commission (WRC)-funded research project applied a variety of methodologies to characterize the geochemistry of basement rock aquifers in Limpopo Province. The research outlines principal processes influencing the groundwater chemistry of basement rocks and ultimately influencing sustainable groundwater supply. In particular the research concentrates on groundwater chemistry resulting from source-rock interaction, and hydrochemical processes including cation exchange, evapotranspiration and dissolution. The methodologies applied in the dissertation include XRD and XRF analysis and ion ratio analysis for water-source deduction and for weathering reactions and factors. The complexity of basement rock aquifers is highlighted if these methodologies are applied to determine the origin of groundwater. The geochemical interactions of these rocks show that a number of factors influence the groundwater composition. Weathering reactions and factors show only a 12% correlation between the minerals, their weathered products and the groundwater cation composition. Furthermore recharge-discharge areas influence most of the anions in the groundwater water. The geochemical characteristics of basement rock aquifers have a dominant Mg-Na-HCO₃ water facies overall and don't show any significant change in chemistry in different host rock types.

Keywords: *Geochemical, hydrochemical, hydrogeological, basement aquifers, hard rock aquifers, groundwater, isotopes*

1 INTRODUCTION

1.1 MOTIVATION

Precambrian crystalline basement rocks occur extensively in the northern part of South Africa and make up more than 40% of the total bedrock geology in Africa (Chilton and Foster, 1997). It is therefore important to understand the aquifer systems associated with these basement rocks since they support a supply of groundwater to a large number of communities. Most of the water supply in the Limpopo Province is groundwater reliant.

Groundwater sampling and isotope analysis provides an essential tool in the understanding of aquifer dynamics (Clark and Fritz, 1997), contributing to significant development of groundwater resources, especially at locations where favourable lithology, structural features and weathering coincide (Chilton and Foster, 1995). In 1998 the Department of Water Affairs (DWA) proposed a project to collect all available groundwater data from government as well as private institutions for the Limpopo Province. This project, the Groundwater Resource Information Project (GRIP), supported the Water Research Commission (WRC) project to determine sustainable yields of potential productive well fields in basement aquifers of the Limpopo Province with special emphasis on the Limpopo (WMA 1) and Letaba/Luvuvhu (WMA 2) Water Management Areas (WMA). In this dissertation the geochemistry of two focus areas within WMA 1 and WMA 2 is characterized from a geological viewpoint together with the testing of the hypothesis to explain the groundwater geochemical characteristics.

1.2 OBJECTIVES

This WRC-funded research project applies and tests a variety of methodologies to characterize the hydrochemistry of groundwater in basement rock aquifers to reach conclusions regarding the processes influencing the geochemical signature and groundwater quality in these rocks. In particular the research concentrates on the following:

- The groundwater chemistry as a result of water reactions involving both the weathered and unweathered aquifer material.
- The groundwater chemistry is influenced by hydrochemical processes such as cation exchange as well as near-surface processes such as evapotranspiration, dissolution and leaching.

- Groundwater evolution according to the groundwater chemistry can be related to dynamic/active groundwater flow systems or non-active groundwater flow systems within the weathered and fractured aquifer systems.

Therefore, the scope of the research is to provide a quantitative understanding of the groundwater chemistry and quality.

1.3 STRUCTURE OF THE DISSERTATION

The first phase of the research consisted of a desktop study during which data were retrieved from the Department of Water Affairs and Forestry (DWAF) and other private institutions. This included available reports, physical information such as borehole data, climate data, chemical data *et cetera* from sources such as National Groundwater Database / Archive (NGDB/NGA) on the study area together with reviewing previous studies done on basement aquifers. The second phase included hydrogeological and geochemical data collection, analysis and interpretation, and presenting the relevance of the hypothesis and conceptualizing a model for the study area. The dissertation layout is as follows:

- Introductory information is given in Chapter 1. The purpose of the research is discussed with reference to the GRIP and WRC project scope. The primary objectives of the WRC project together with the specific objectives of the MSc research study, i.e. groundwater quality and hypothesis are defined.
- Chapter 2 includes a literature study on basement aquifers describing the general basement aquifer model and characteristics of basement aquifers, which will provide an insight into basement aquifer systems and an understanding thereof. The literature review allowed comparisons to be made with the data retrieved throughout the project research.
- Chapter 3 includes a discussion on different methodologies and hypotheses for the occurrences of geochemical signatures and other overriding properties affecting the geochemical characteristics of groundwater.
- The physiography of the research area is presented in Chapter 4. This includes information on the locality, geomorphology, climate and vegetation of the study areas.
- Chapter 5 presents the regional geology of the study area, outlining the regional setting of different rock types. The lithologies, formational history and neotectonic activities are presented.

- An analysis and interpretation of the groundwater characteristics are presented in Chapter 6. The data retrieved during the literature review as well as data collected during the study are presented and discussed.
- Chapter 7 describes the main findings addressing the objectives of the dissertation. A conclusion on the geochemical characteristics and discussion of the hypothesis with its overriding processes leading to the geochemical signatures found in the study area is given.

2 LITERATURE REVIEW

This chapter provides a general overview of the characteristics of basement aquifers internationally as well as within South Africa. The literature review provides an insight into the development and characteristics of basement aquifer systems.

2.1 OVERVIEW OF BASEMENT AQUIFERS

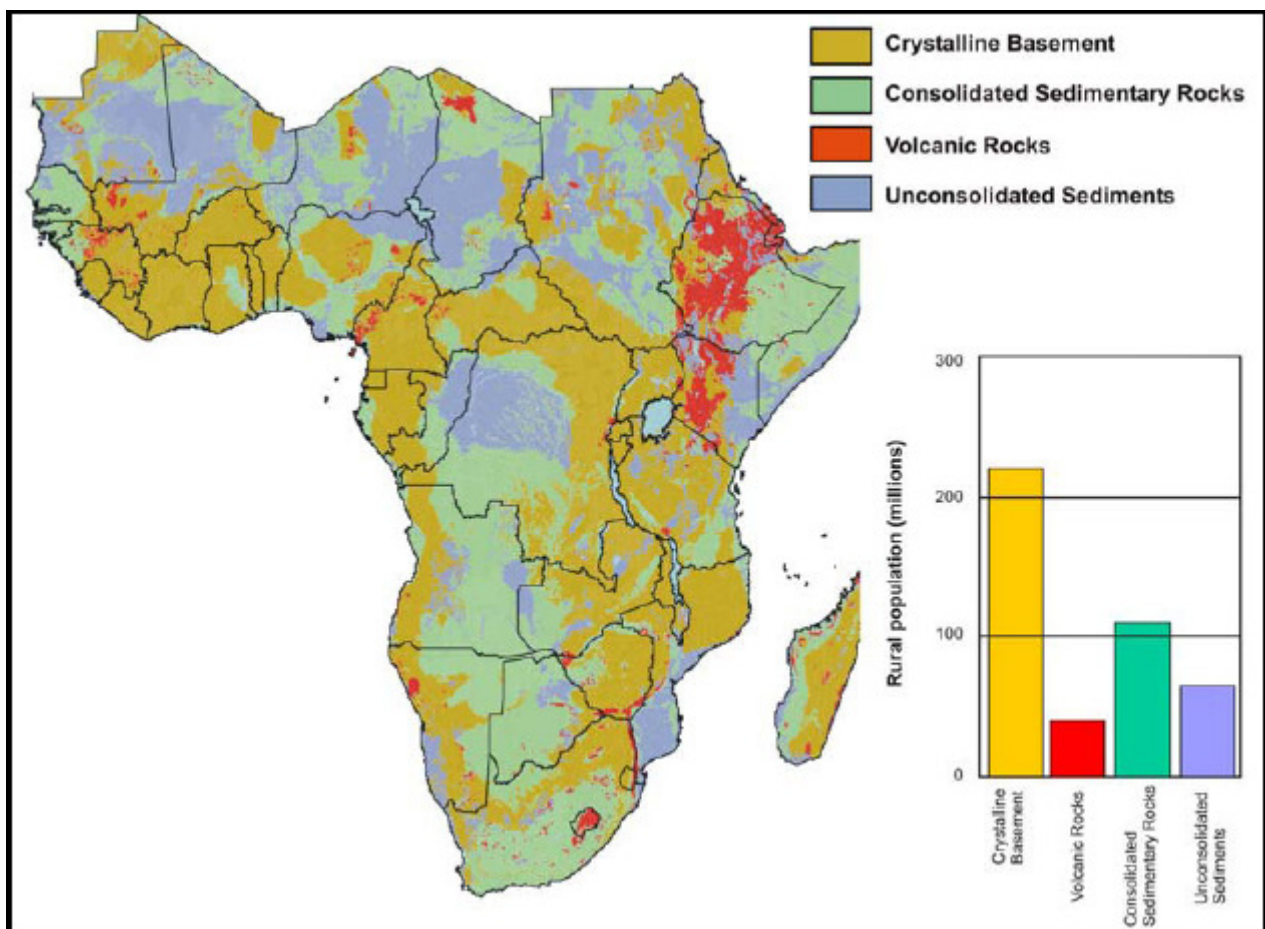


Figure 1: Occurrence of Crystalline Basement Rocks in Africa (Source: MacDonald, 2005)

The extent of crystalline basement rocks occurring in Africa is shown in Figure 1. As described by Wright and Burgess (1992), basement aquifers develop within the weathered overburden (i.e. regolith) and fractured bedrock of crystalline rock of intrusive as well as metamorphic origin, which are mainly of Precambrian age. Basement aquifers are distinctive in their occurrence and their characteristics are largely related to weathering processes, recharge and groundwater through-flow. Thus a close relationship exists between the relief, soil, vegetation cover and surface water hydrology. Structural features such as faults, lineaments and shear zones also play an important role in the development of basement aquifers. Crystalline basement rocks have generally been subjected to multiple tectonic events under a variety of stress conditions, resulting in complex patterns of ductile folding and brittle fracturing (Lloyd, 1999). The characteristics of basement aquifers and their associated groundwater resource properties are greatly influenced by the dominant conditions (structurally controlled flow) within the environment (Acworth, 1987). Lloyd (1999) concluded that fresh unweathered basement rocks are poor aquifer materials. Fractures are the most important aspect of aquifer potential but are inconsistent laterally and in depth. Weathering doesn't always enhance the potential of the fractured hard rock. Lloyd (1999) also suggested that basement aquifers should be assessed and developed in conjunction with any juxtaposed aquifer material indicating that the origin and quality of groundwater signatures will be influenced by surrounding soil and rock material.

According to Lloyd (1999), crystalline materials generally comprise an unweathered and intact matrix with planes of discontinuity (including both faults and joint planes) and often fill from late phase fluids. These two inter-linking systems, a weathered and often clayey overburden with low to moderate transmissivity but high storativity and fractured bedrock with a generally low storativity but high transmissivity, dominate the groundwater flow in basement aquifers. A regional conceptual model for basement aquifers (Chilton and Smith-Carington, 1984; Chilton and Foster, 1995; Wyns et al., 2004), seen in Figure 2, represents a multi-faceted aquifer that can be subdivided into two aquifer systems; a highly weathered (i.e. regolith) aquifer system and a highly fractured crystalline hard rock aquifer system. The highly weathered aquifer systems with weathered fissured structures, will most probably give the best sustainable yield values (2003). However, the development of a thick weathered profile requires specific climatic conditions, such as high rainfall to ensure hydrolysis, as well as high mean temperatures to favour kinetic processes for pedogenesis and long term stable tectonic conditions (Peltier, 1950; Ollier, 1984; Tardy, 1971 and 1998). Geological features such as dykes, faults, lineaments and inselbergs will locally change the mineralogy as well as the weathered profile influencing the multi-faceted aquifer system.

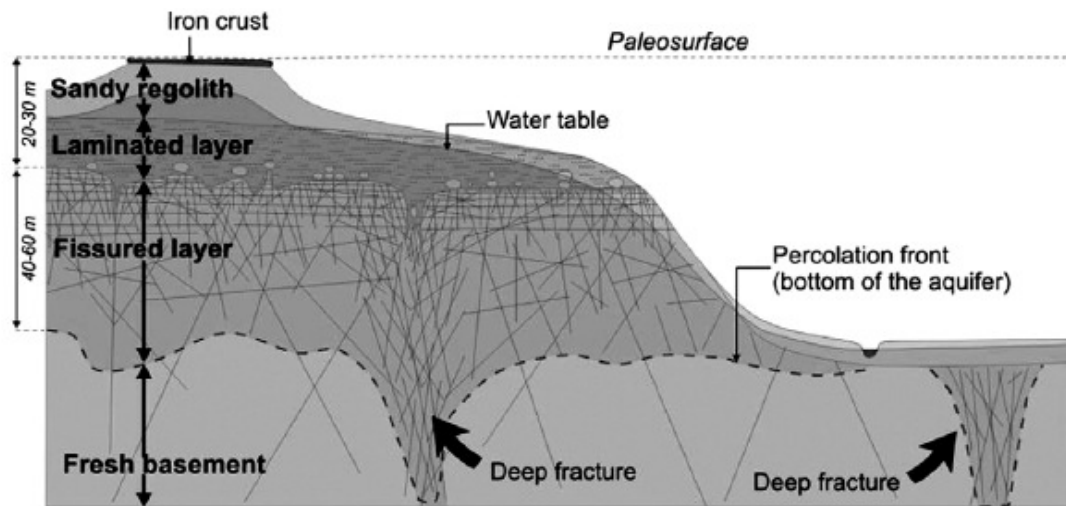


Figure 2: Weathering profile in crystalline hard rock (Source: Wyns et al., 1999).

According to Clark (1985), the groundwater quality within basement aquifers is generally good with low salinities. The shallow groundwater in pediment areas might show high iron concentrations because of solution of iron from the lateritic soils. The most likely groundwater quality problem is pollution. Clark (1985) wrote that elevated nitrate levels are expected in urban areas where bacterial infection is due to sewage effluent. Open wells/boreholes may also be infected by pathogenic organisms such as guinea worms and amoebae (Cairncross and Feachem, 1993). According to Chilton and Forster (1995) the natural chemical quality of groundwater in basement aquifer systems in tropical Africa is considered to be acceptable. Titus (2003) found that within temperate climatic zones TDS varies between 100mg/l and 300mg/l, whereas in semi-arid regions TDS values exceed 2000mg/l with bicarbonates and calcium as dominant ions.

2.1.1 Weathered overburden (Regolith)

Historic weathering and erosion processes have resulted in the formation of a weathered overburden or regolith zone with altered products (Taylor and Howard, 2000; Chilton and Foster, 1995; Gustafson and Krásny, 1994 and Acworth, 1987). The thickness of the weathered overburden depends on the mineralogy, petrology, structure of the rocks, duration of geomorphological conditions of weathering, and quantity of recharge (Acworth, 1987; Reboucas, 1993; Gustafson and Krasny, 1994). The hydraulic properties of the regolith are mainly influenced by geomorphological weathering processes as well as the underlying geology (Wyns et al., 1999 and 2004; Taylor and Howard, 2000). These processes involve the biogeochemical hydrolysis of the mineral components of the rock and the mineral transformation (Tardy, 1971, 1993, 1998; Nahon, 1991). Studies done by Chilton et al. (1984); Chilton and Foster (1995); Wyns et al. (2004) contributed to a typical weathered soil profile model which comprises of the following soil layers:

- A laterite layer which may be absent due to erosion or rehydration of hematite or resiliification of gibbsite/boehmite into kaolinite.
- Underlying the laterite layer a clay rich saprolite layer resulting from prolonged in-situ weathering and leaching of minerals forming horizons of a few tens of metres thick. This layer may show a highly mineralogical weathered clay-rich lens that has lost all structural characteristics of the underlying rock or/and slightly weathered laminated bedrock consisting of the original structural characteristics of the underlying rock. This horizon shows a high porosity of between 5% and 30%, (Compagere et al., 1997; Wyns et al., 1999 and 2004; White et al., 2001; Begonha and Braga, 2002), and a low permeability of 10^{-6} m/s (Acworth, 1987; Rushton and Weller, 1985; Houston and Lewis, 1988; Barker et al., 1992), due to the clayey sandy nature. The hydraulic conductivity is influenced by the clay rich material which is again influenced by the mineralogical composition of the parent rock as well as the degree of weathering, with a general decrease towards the top of the layer. The base of the saprolite has a coarse sandy clastic texture with hydraulic conductivity values ranging between 5×10^{-7} and 3×10^{-3} m/s (Dewandel, et al 2006).
- A fissured layer consisting of a dense accumulation of fissures in the first few metres of the weathered overburden and, a decreasing in sub-horizontal and sub-vertical fissures with increasing depth. Swelling of minerals such as biotite in granites causes a local shrinking and swelling of the ground volume resulting in cracks and further fissure development. Due to the closing and filling of the structures with active clays the hydraulic conductivity decreases towards the top as the fissures are filled. However, this is still the most permeable layer of the entire profile, depending on the connectivity of the fractures (Dewandel, et al 2006). Both granites and gneisses (i.e. highly foliated rocks) show preferential orientations of the fissures influenced by bed rock structures (Pye, 1986; Sharma and Rajamani, 2000).
- The deeper crystalline hard rock (i.e. basement rocks) is only locally permeable due to structural fractures. The fresh basement is considered to be impermeable with very low storativity in non-fractured zones.

2.1.2 Fractured basement rock aquifers

Crystalline basement rocks are characterized by a combination of semi-permeable porous rock with secondary openings or fractures. These secondary openings in the rock matrix are structurally controlled and forms include joints, shear zones, fractures, foliation, etc. These secondary voids influence groundwater flow from the micro scale to the massive scale found in crustal rifting (Bonnet et al., 2001).

2.2 GROUNDWATER FLOW IN BASEMENT AQUIFERS

The basal part of the regolith, which is the approximate base of the saprolite, and the top of the weathered saprock, (i.e. the weathered bedrock), has sufficient permeability to support successful boreholes for small-scale village water supply (Chilton and Foster, 1995). Rebouças (1993) supported this statement and referred to the most productive zone for groundwater development as corresponding to the lowest zone of the weathered profile and top of the fractured bedrock. Rebouças (1993) stated that the optimum zone for groundwater development is from 20 metres to 50 metres depth. Furthermore, a thick saturated regolith is essential (especially in humid regions) for adequate aquifer storage and available drawdown (Chilton and Foster, 1995). The average yield from a production borehole in weathered basement aquifers is normally less than 1 l/s (Chilton and Foster, 1995). The average yield for wells and boreholes located in fractured and/or weathered rocks is 16 m³/h for Brazil compared to an average yield of 3 m³/h for certain countries in Western Africa (Rebouças, 1993). The groundwater usually has a low total dissolved solid load (TDS) of less than 100 mg/l. Groundwater within the lowermost unweathered basement rocks is stored in interconnected systems of fractures, joints and fissures associated with regional tectonism (Rebouças, 1993). The yields from these unweathered basement aquifers, located in humid and sub-humid tropical climatic sub-regions, vary between 1 m³/h and 20 m³/h with a TDS of less than 100mg/l (Rebouças, 1993). Fractured crystalline rocks in Namaqualand are characterized by extreme heterogeneity in their hydraulic properties with poor connectivity between fractures. Water is stored and transmitted in these fractures and fissures, which serve as hydraulic conductors, through a relatively impermeable matrix.

Van Schalkwyk and Vermaak (2000) discussed the groundwater flow from a geotechnical and a hydrogeological perspective. A short explanation of their results is given below.

2.2.1 Flow of liquids in a saturated and unsaturated medium

Fluid in a porous media possesses different forms of energy due to the effect of gravitational and matrix forces. Thus, the flow of fluid will occur due to the difference in hydraulic head and will flow in the direction of the lesser hydraulic head or lesser energy (Bell, 1993). Darcy's empirical formula describes the macroscopic flow of fluids through a porous medium.

$$v = -K \frac{dh}{dz}$$

The flow of liquid is therefore directly proportional to the driving force acting on the liquid, the hydraulic gradient (dh/dz), and also the ability of transmitting through a conductive medium, hydraulic conductivity, K (Hillel, 1980).

The fluid flow through a porous medium consists of voids and solid particles, thus the fluid velocity through the geological profile is actually greater due to the tortuous movement between the solid particles flowing through the voids. The true velocity (V_s) on a microscopic scale can be approximated by the following equation depending on the soil porosity (θ_s);

$$v_s = -\frac{k \frac{dh}{dz}}{\theta_s}$$

Thus, the flow of fluid is directly related to the forces acting on it as well as the ability of the porous medium to conduct and transmit the liquid (Hillel, 1980).

In saturated conditions fluid behaviour is furthermore affected by three other factors namely (Van Schalkwyk and Vermaak, 2000);

- Properties of the fluid (all in unsaturated conditions)
- Properties of the porous medium and
- Interaction between the fluid and the porous medium.

Interaction between the fluid and the porous medium differs in different soil types. A clayey soil will show higher interaction of the fluid due to electric forces at molecular level than sandy soil. Taking this out of consideration as the influence on total flow is only marginally influenced by the electric forces, the following equation can be used to describe the hydraulic conductivity (K)

$$K = kf$$

Where k is the permeability and f is the fluidity thus indicating that the hydraulic conductivity is dependent on the fluid medium properties.

The most important difference between saturated and unsaturated conditions is the hydraulic conductivity, as the soil becomes less conductive with increasing desaturation (Hillel, 1980). The hydraulic conductivity in a porous medium is a function of the volumetric water content, $K(\theta)$, gradient and area (A). Thus fluid flow in unsaturated conditions s can be expressed as follow;

$$q = -K(\theta) \frac{dh}{dz} A$$

In unsaturated conditions, apart from the gravitational forces, three other forces act on the fluid behaviour namely, capillary forces, adsorption forces and electrical forces at molecular level.

Another factor influencing the behaviour of fluid movement is preferential flow which is the process by which a fluid moves along preferred pathways including fractures, joints and other existing channels in both soil and rock through a porous medium (Helling and Gish, 1991). Preferential flow plays an important role in groundwater recharge as shown by Van Tonder and Kirchner (1990).

Preferential flow is affected by a variety of factors, and some of the more important are:

- Macropore channelling
- Fingering
- Funnel flow

Macropore channelling refers to the fluid that bypasses the soil matrix and flows into the saturated horizon due to large open spaces formed by a variety of factors and processes. These processes including pores formed due to fauna (i.e. ants, earthworms, moles, rodents, etc.), flora (i.e. plant roots), fissures and fractures forming due to active clays, piping, joints, bedding planes, foliation planes, faults and/or geological contact zones. These macropores may cause rapid movement through the soil, increasing the flux rate and thus increasing the recharge.

Fingering flow refers to the process where a fluid moves downwards into the soil matrix in columnar structures due to easier accessibility or flow movement (Van Schalkwyk and Vermaak, 2000). Basically, fingering describes the process of the wetting front becoming unstable. When two or more forces act on a fluid, the fluid movement will be in the direction where the one force exceeds the other. E.g. water flowing through a less permeable layer may cause wetting front instability.

Funnelled flow refers to the preference of the fluid to move laterally on top of a coarse grained soil layer (Kung, 1990). This happens because water flowing in a less permeable zone cannot enter a more permeable zone due to a difference in pore water pressure (capillary barrier). Factors affecting funnel flow include:

- Inclination of the underlying layer
- The flux of the overlying layer
- The hydraulic conductivity of the overlying layer
- The difference in hydraulic conductivity between two layers

The saprolite is subjected to weathering, erosion, pedogenic and other processes causing the complexity and heterogeneity of the profile. The voids within this zone are usually partially filled by either fluid and/or vapour (gas). This layer can further be divided into three subzones namely the capillary fringe, capillary zone and discontinuous zone (Martin and Koerner, 1984) as shown in Figure 3. The three subzones are defined as follows:

- The capillary fringe is a zone that occurs directly above the groundwater level, indicating that the zone is saturated. The capillary fringe will be thicker in fine grained soils compared to coarse grained soils.
- The capillary zone consists of soil in which the pores are filled with air and water, with water filling the smaller voids and gases the larger voids. Pore water pressure decreases upwards in the profile (further away from the groundwater level) which causes water to retreat into smaller pores leading to a decrease in water content. Fine-grained soils can hold high volumes of water for large vertical distances from the groundwater level.
- In the discontinuous zone water is only found as adsorbed water due to the low capillary forces acting on the water away from the groundwater level. Evapotranspiration usually plays a role in removing water from this zone.

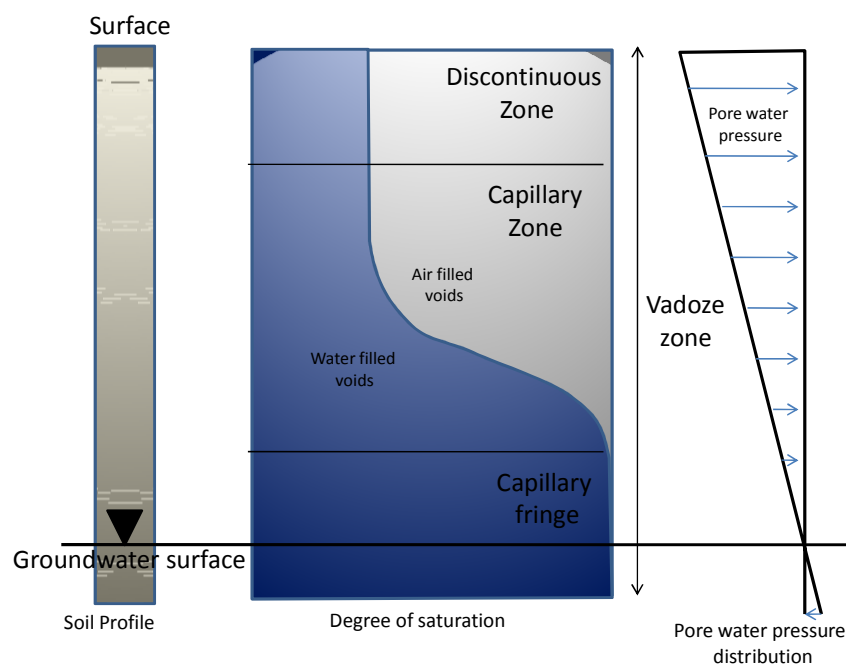


Figure 3: Vadoze zone indicating soil-water content (after Martin and Koerner, 1984a)

2.2.2 Fluid flow in a fractured rock aquifer system

Fluid behaviour in fractured rock aquifers is mainly dependant on the degree of fracturing, size or dimension, continuity, roughness, connectivity and porosity of the matrix. Flow within fractures can be turbulent, although laminar flow prevails most of the time. Witherspoon et al. (1980) determined the hydraulic conductivity of fractures, bearing in mind that the fluid flow is laminar, through smooth, parallel planar plates, as follows:

$$K_f = \frac{(2b)^2 \rho f g}{12\mu}$$

The hydraulic conductivity (K_f) determined for simple fracture systems depends on aperture half-width (b), fluid density (ρ), gravitational acceleration (g) and the viscosity (μ).

The roughness of fracture planes causes friction and will influence fluid flow. Wittke (1990) discussed the influence of roughness and proposed the following equation to determine the hydraulic properties of a fracture.

$$D_h = 4 \frac{A}{P} \rightarrow \frac{k}{D_h} = \frac{k}{4a_i}$$

Wittke (1990) calculated the hydraulic diameter (D_h) by measuring the absolute wall roughness (k) and the mean fissure width to distinguish between the irrotational and rotational.

2.3 WEATHERING AND WATER QUALITY IN BASEMENT ROCKS

Chemical weathering in crystalline rock aquifers is found below the groundwater table, influencing changes in mineralogy and consequently influencing the groundwater chemistry. Factors such as the parent rock grain size, texture, degree of fracturing, fissures and joints affects the groundwater flow and thus the weathering processes. Titus (2003) discussed the weathering and production of the regolith zone in Namaqualand implying that the weathered zone is the result of infiltrating rainfall reacting with the host rock minerals followed by leaching of more soluble and mobile elements together with precipitation of less mobile elements. Water is the main weathering agent through hydrolysis and dissolution. However, factors such as drainage, pH and redox potential influence the progress and the products of weathering. The water quality affects the susceptibility of minerals to alteration. Silicate removed from the system through hydrolysis produces various aluminium silicates, usually as pseudomorphs (substitution of a mineral component). However, if silicate is not removed, clay minerals form as the weathered product. Krauskopf (1967) demonstrated the change in mineralogy during the weathering of a quartz-feldspar-biotite gneiss. Olivine and pyroxene are the most readily broken down minerals, followed by amphiboles and then more stable micas, which again produce clay minerals. Ca-plagioclase is the most readily weathered feldspar followed by Na- and K-feldspars breaking down to clay minerals. The weathered zone is usually characterised by an accumulation of secondary clay minerals with both primary minerals and intermediate weathered products. Appelo and Postma (1994) have published typical weathering and dissolution reactions (Table 1).

Table 1: Typical weathering and dissolution reactions from certain mineral (Appelo and Postma, 1994)

Minerals	Weathering reactions
Kaolinite from Albite:	$2 \text{NaAlSi}_3\text{O}_8 + 2 \text{H}^+ + 9 \text{H}_2\text{O} \rightarrow \text{Al}_2\text{Si}_2\text{O}_5(\text{OH})_4 + 2 \text{Na}^+ + 4 \text{H}_4\text{SiO}_4$
Kaolinite from Pyroxene:	$[\text{CaMg}_{0.7}\text{Al}_{0.3}\text{Si}_{1.7}\text{O}_6] + 3,4\text{H}^+ + 1,1\text{H}_2\text{O} \rightarrow 0,3 \text{Al}_2\text{Si}_2\text{O}_5(\text{OH})_4 + \text{Ca}^{2+} + 0,7 \text{Mg}^{2+} + 1,1 \text{H}_4\text{SiO}_4$
Kaolinite from Biotite:	$2\text{K}[\text{Mg}_2\text{Fe}][\text{AlSi}_3\text{O}_{10}(\text{OH})_2] + 10\text{H}^+ + 0,5\text{O}_2 + 7\text{H}_2\text{O} \rightarrow \text{Al}_2\text{Si}_2\text{O}_5(\text{OH})_4 + 2 \text{K}^+ + 4 \text{Mg}^{2+} + 2 \text{Fe}(\text{OH})_3 + 4 \text{H}_4\text{SiO}_4$
Kaolinite from Muscovite:	$2\text{KAl}_2(\text{AlSi}_3\text{O}_{10}(\text{F},\text{OH})_2) + 10\text{H}^+ + 0,5\text{O}_2 + 7\text{H}_2\text{O} \rightarrow \text{Al}_2\text{Si}_2\text{O}_5(\text{OH})_4 + \text{Fe}(\text{OH})_3 + 4\text{H}_4\text{SiO}_4 + 2\text{K}^+$
Kaolinite from K-Feldspar:	$2 \text{KAlSi}_3\text{O}_8 + 2 \text{H}^+ + 9 \text{H}_2\text{O} \rightarrow \text{Al}_2\text{Si}_2\text{O}_5(\text{OH})_4 + 2 \text{K}^+ + 4 \text{H}_4\text{SiO}_4$
Kaolinite from Hornblende	$\text{Na}_{0.5}\text{Ca}_2(\text{Fe}_{1.3}\text{Mg}_{2.6}\text{Al}_{1.1})\text{Al}_{1.6}\text{Si}_{6.4}\text{O}_{22}(\text{OH})_2 + 9,7\text{H}^+ + 11,65\text{H}_2\text{O} + 0,325\text{O}_2 \rightarrow 0,5\text{Na}^+ + 2\text{Ca}^{2+} + 2,6\text{Mg}^{2+} + 1,3 \text{FeO}(\text{OH}) + x\text{Al}_2\text{Si}_2\text{O}_5(\text{OH})_4 + (2,7-2x)\text{Al}(\text{OH})_3 + (6,4-2x)\text{H}_4\text{SiO}_{4(\text{aq})}$
Kaolinite from Gibbsite	$\text{Al}_2\text{O}_3 \cdot \text{H}_2\text{O} + 2\text{Si}(\text{OH})_4 \rightarrow \text{Al}_2\text{Si}_2\text{O}_5(\text{OH})_4 + 5\text{H}_2\text{O}$
Montmorillonite from Albite :	$3\text{NaAlSi}_3\text{O}_8 + \text{Mg}^{2+} + 4\text{H}_2\text{O} \rightarrow 2 \text{Na}_{0,5}\text{Al}_{1,5}\text{Mg}_{0,5}\text{Si}_4\text{O}_{10}(\text{OH})_4 + 2 \text{Na}^+ + \text{H}_4\text{SiO}_4$
Gibbsite from Albite:	$\text{NaAlSi}_3\text{O}_8 + 7 \text{H}_2\text{O} \rightarrow \text{Al}(\text{OH})_3 + \text{Na}^+ + 3 \text{H}_4\text{SiO}_4$
Gibbsite from Kaolinite:	$\text{Al}_2\text{Si}_2\text{O}_5(\text{OH})_4 + 5 \text{H}_2\text{O} \rightarrow \text{Al}_2\text{O}_3 \cdot 3 \text{H}_2\text{O} + 2 \text{H}_4\text{SiO}_4$
*Montmorillonite from K-feldspar	$1,7\text{KAlSi}_3\text{O}_8 + 0,11\text{Fe}_2\text{O}_3 + 0,485\text{Mg}^{2+} + 3,27\text{H}_2\text{O} + 0,74\text{H}^+ \rightarrow \text{Mg}_{0,195}(\text{Al}_{1,52}\text{Fe}^{\text{III}}_{0,22}\text{Mg}_{0,29})(\text{Al}_{0,19}\text{Si}_{3,81})\text{O}_{10}(\text{OH})_2 + 1,71\text{K}^+ + 1,32\text{H}_4\text{SiO}_4$
*Montmorillonite from muscovite	$0,57\text{KAl}_2(\text{Si}_3\text{Al})\text{O}_{10}(\text{OH})_2 + 0,11\text{Fe}_2\text{O}_3 + 0,485\text{Mg}^{2+} + 2,1\text{H}_4\text{SiO}_4 \rightarrow \text{Mg}_{0,195}(\text{Al}_{1,52}\text{Fe}^{\text{III}}_{0,22}\text{Mg}_{0,29})(\text{Al}_{0,19}\text{Si}_{3,81})\text{O}_{10}(\text{OH})_2 + 0,57\text{K}^+ + 3,57\text{H}_2\text{O} + 0,4\text{H}^+$

*Source: Essington M.E. (2003)

2.3.1 Case studies of Basement rock aquifers

The British Geological Society (BGS) (unpubl.) carried out a groundwater resource assessment investigation on crystalline rock aquifers all over Africa to improve typical boreholes drilling programs. The crystalline hard rock aquifer's geological setting is very similar compared with basement rocks found in the Limpopo Province in South Africa. Groundwater occurred in three main aquifer zones controlled largely by topography and weathering. These three zones are a near surface weathered zone, deeper weathered zone and a fracture zone in bedrock beneath the weathered zones. The near surface weathered zone is characterized by sandy soils with ferricrete underlain by clay. The deeper weathered zone consists of fractured and less weathered bedrock beneath the near surface clay layer extending to depths of 40 metres followed by unweathered

fractured bedrock. The groundwater quality within the Tabora region in Tanzania, seen in Figure 4, showed that the weathered rocks are generally of Na-Cl or Na-HCO₃ types. Conductivities in almost half of their sampled boreholes were below 200µS/cm. However, in about a third of their sampled boreholes the conductivity was above 1200µS/cm. The boreholes sampled by the British Geological Society in the weathered aquifer zones showed recently recharged groundwater. The boreholes tapping the deeper fractured aquifer zone retrieved older groundwater within the fractures that was highly mineralized through ion-exchange processes during the long contact time with the surrounding rocks. During the rainy season, these highly mineralized groundwaters are flushed by recent recharge resulting in a decrease in groundwater salinity. Fluoride levels were low in most of the analyzed groundwater samples except for a third of the samples which had concentrations above 1.5 mg/l which exceeding the World Health Organisation (WHO) limit. Most of the sampled boreholes showed low levels of nitrate (and often chloride) indicating minimal levels of faecal and other organic pollutants. Groundwater in shallow ferricrete is usually young, recharged seasonally, and would be expected to have low conductivity with high iron concentrations being common, related to the iron-rich nature of the ferricrete material.

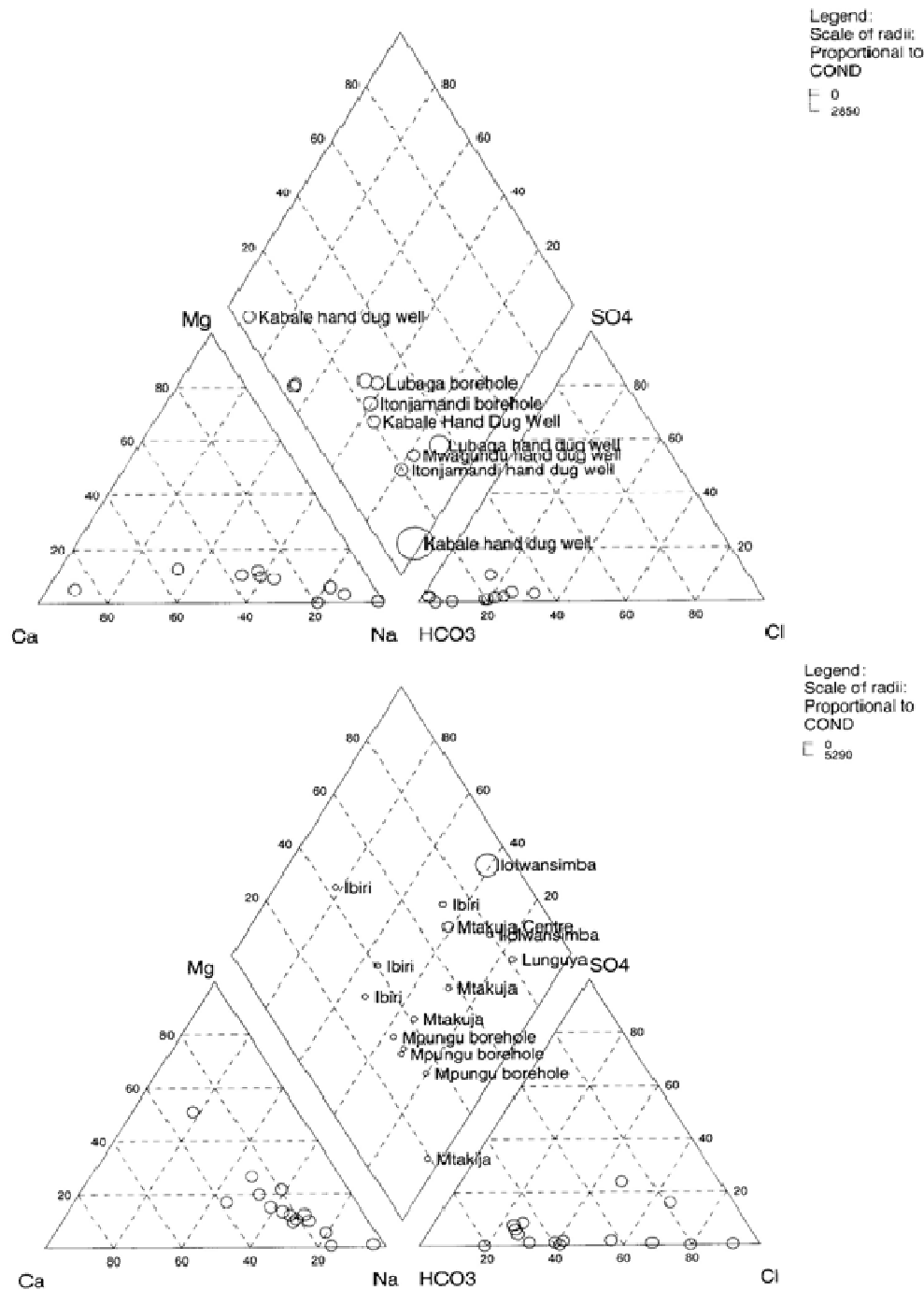


Figure 4: Piper plots of the hydrochemistry for the groundwater samples of the Tabora region in Tanzania (British Geological Society, unpublished)

Chimpbamba et al. (unpublished) did a review on the groundwater quality of Malawi which is underlain almost entirely by basement rocks. From Chimpbamba et al (unpublished) the Malawi Government-UNDP study (1986) found that there are two main aquifer types in Malawi; the extensive but low yielding basement aquifer and higher yielding alluvial aquifer. According to Chimpbamba et al. (unpublished), the groundwater quality in Malawi is generally acceptable for

domestic use, but some areas exist where high ion concentrations render the water unacceptable for human consumption. Groundwater samples from basement aquifers located in the plateau areas have low conductivities ($750\mu\text{S}/\text{cm}$) whereas boreholes located in the escarpment had high conductivities (ranging up to $3000\mu\text{S}/\text{cm}$). Some samples analyzed had fluoride values above allowed concentrations for human consumption, leading to possible health problems (fluorosis). The groundwater samples collected and analyzed show a typical chemical evolution trend from magnesium to potassium cation and from bicarbonate to chloride anion as seen in Figure 4. Common major cation and anion ranges for Malawi are summarized in Table 2.

Table 2: Common ranges in water quality of groundwater (Malawi Government-UNDP, 1986))

Parameter	Unit	Weathered Basement	Alluvial aquifers
Electrical conductivity	$\mu\text{S}/\text{cm}$	100-1000	500-3000
Total dissolved Solids	mg/l	60-600	300-1800
Calcium	mg/l	10-100	50-150
Magnesium	mg/l	5-50	20-100
Sodium	mg/l	5-70	20-1500
Potassium	mg/l	1-6	1-6
Total Iron	mg/l	1-5	1-5
Bicarbonate	mg/l	100-500	200-1000
Sulphate	mg/l	5-1000	20-2000
Chloride	mg/l	Less than 20	20-2000
Nitrate	mg/l	Less than 5	Less than 5
Fluoride	mg/l	Less than 1	2-10

Rabemanana et al. (2005) did a study in southern Madagascar, assessing the cause of the high spatial variability of the mineral content in the groundwater in crystalline basement bedrocks. Chemical and isotope data, seen in Figure 5, were used to identify the processes affecting groundwater mineralization. Rabemanana et al. (2005) found that the groundwater is characterized by high contents of sodium and chloride as well as alkalinity. The sodium concentrations varied from $29\text{mg}/\text{l}$ to $992\text{mg}/\text{l}$ with a median of $192\text{mg}/\text{l}$. The chloride content ranged from $27\text{mg}/\text{l}$ to $1489\text{mg}/\text{l}$ with a median of $160\text{mg}/\text{l}$. According to Rabemanana et al. (2005) almost all groundwater samples had sodium as dominant cation followed by magnesium. High nitrate levels were observed, classifying these samples as unacceptable for human consumption. Bicarbonate is the dominant anion but with increasing conductivity chloride becomes more dominant. The following dominant groundwater types were identified; $\text{Na-HCO}_3\text{-Cl}$, Mg-HCO_3 , Na-Cl-HCO_3 and Na-Cl . The dissolved ions in groundwater were mainly derived from three

processes; water-rock interaction (weathering of silicate and carbonate or leaching of evaporitic salts), salt effects (i.e. flushing of salt rich minerals into the system after rainfall event) and anthropogenic input. The isotope analysis showed that $\delta^{18}\text{O}$ values ranged between -5.6 to -4.1 and $\delta^2\text{H}$ values between -39.2 and -30.4. Compared to the Global Meteoric Water Line (GMWL) all samples are depleted in deuterium, indicating that the groundwater was subjected to evaporation before or during infiltration. Rabemanana et al. (2005) also found that accumulation of salts by evaporation occurs mainly in topographical lower or flatter areas and whenever recharge takes place, it leaches soluble salts into the saturated zones.

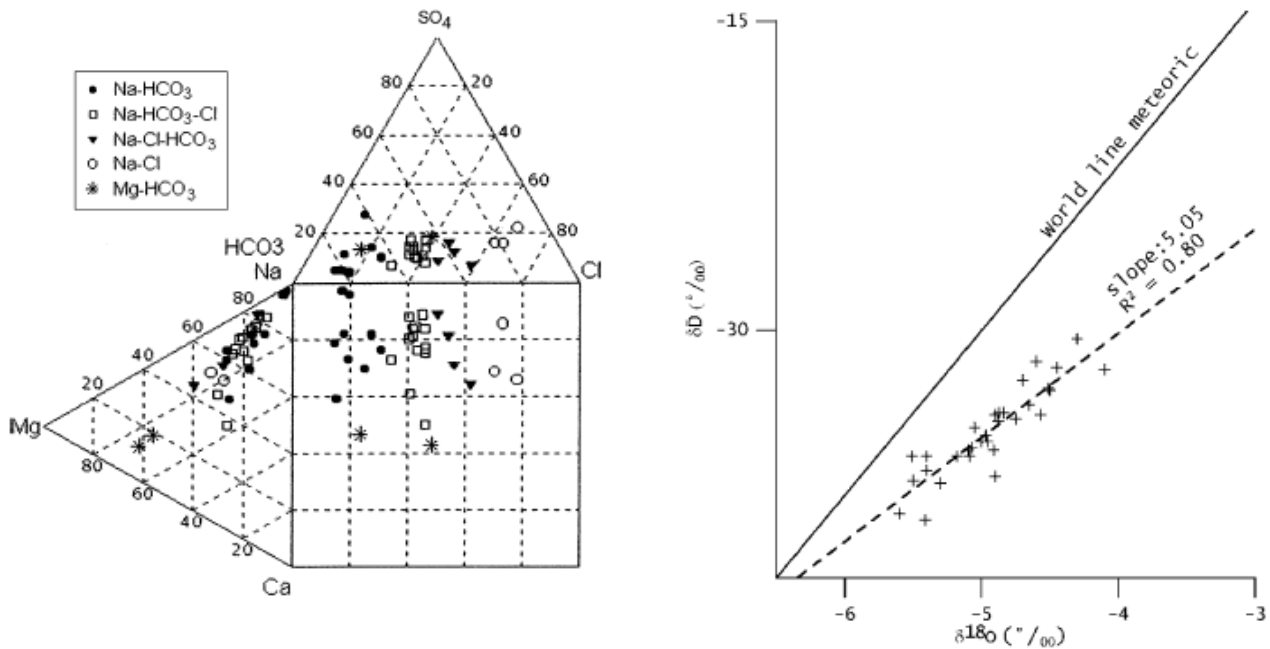


Figure 5: Piper plot of the water quality with respect to the water type and isotope plot.
(Rabemanana et al, 2005)

A series of information sheets for each country in which the British charity organisation WaterAid works was prepared by the British Geological Society to identify inorganic constituents of significant risk to health that may occur in groundwater. The findings from two of these studies are presented below.

The groundwater quality in basement rocks in Madagascar is generally “soft”, i.e. low calcium and magnesium concentrations in the silicate rocks (i.e. crystalline basement rock) with pH typically between 6 and 7 and low salinity values (i.e. fresher groundwater). However, deeper groundwater from the basement complex is affected by high salinities in some areas. Where carbonate rock types occur, the groundwater is harder with near natural pH values (i.e. pH 7 or more). The information sheets done by the BGS describe that upwelling groundwater along deep fracture zones in the crystalline basement rocks is more mineralized than shallow groundwater, changing the water quality locally. Nitrogen (i.e. NO_3 as N) levels were relatively high and above the WHO

guidelines (>11.3 mg/l) in the shallow groundwaters, which is most likely as a result of pollution. In the high plateau areas shallow groundwater commonly has a low mineralization due to high rainfall and rapid water infiltration. Deeper groundwaters in parts of the crystalline basement rocks show saline (sodium-chloride) water types.

The groundwater quality recorded in basement rocks in Tanzania is generally soft (low calcium and magnesium concentrations) with high pH values and relatively high sodium concentrations as well as high alkalinity. Total dissolved solids range between 1000 and 3000 mg/l, indicating highly elevated mineralisation of groundwaters. One of the biggest water quality problems occurring in Tanzania is elevated fluoride concentrations. Fluoride build-up in groundwater from the crystalline basement rocks in the plateau area derives from the dissolution of fluoride minerals such as fluorite and apatite. The distribution of recorded nitrate concentrations in boreholes located in Tanzania is limited, however some high concentrations (up to 102 mg/l as N) have been reported in shallow and deep groundwater. These elevated values were linked to pollution with sewage effluent with penetration of these effluents into deeper groundwater along fractures.

Titus (2003) did an investigation in Namaqualand on the hydrogeochemical processes that influence the groundwater chemistry of basement rocks in Namaqualand, South Africa. According to Titus (2003) the dominant groundwater type has a Na-Cl signature through the recorded EC ranges, describing it as slowly circulating relatively old groundwater. The limited groundwater samples with Ca-HCO_3 and Na-HCO_3 signatures may be attributed to carbonate dissolution in the soil zone and localized recharge processes refreshing the groundwater composition. A few Na-SO_4 and Mg-SO_4 type waters were associated with mining and agricultural activities. The dominant Na-Cl character of the subterranean waters is a result of the direct infiltration of Na-Cl dominated precipitation and/or the preferential dissolution and leaching of the more soluble evaporitic salts during the infiltration process.

Titus (2003) concluded that groundwater chemistry depends on the point of sampling in either a dynamic or an evaporation-dominated, sluggish groundwater system. Stacked, multiple flow systems differ in terms of the factors influencing both the groundwater flow and chemistry, including the recharge rate, hydraulic gradient and hydraulic conductivity. The rate of groundwater flow influences the reaction rates with primary and secondary mineral phases, which in turn influences the resultant groundwater chemistry. Superimposing and probably masking the latter processes is the direct infiltration of Na-Cl dominated precipitation and the preferential dissolution and leaching of the more soluble evaporitic salts during the infiltration process.

3 METHODOLOGY

The hypothesis, describing the possible geochemical characteristics of basement groundwater (e.g. water facies), will be discussed. Different rock type samples characterizing basement aquifers within WMA 1 and WMA 2 were collected and analyzed to determine the mineral composition giving possible differences in groundwater mineral signature. The different rock samples were analyzed using XRD to determine the amount of minerals within the selected rocks.

3.1.1 Sample collection

A hydrocensus was conducted for the selected quaternary catchments in WMA 1 and WMA 2 consisting of the two focus areas. The sampling campaign started at the beginning of May 2007 and ended at the beginning of June 2007. A total of 52 groundwater samples were collected. Furthermore a data set of 1703 borehole samples from the GRIP II and NGDB with complete major cat-and anion concentrations including 966 borehole samples with topographical and 666 borehole samples with geological settings was analyzed. The samples with no geological setting were spatially characterized according to the rock types using Arc GIS 9.2 software. It was assumed that the topographical and geological setting influence the groundwater chemistry.

Apart from the groundwater sampling and data collection, rock grab samples were taken in the field as well as soil samples in two test pits at selected depths. These rock grab samples were analyzed using XRD and XRF to determine the mineral composition and phases.

3.1.2 Geochemistry

All the groundwater samples were collected after a sufficient period of purging of the boreholes as most of the boreholes functioned only for a few hours per day. Samples were collected and kept cool before transporting them to the laboratory. Parameters that were measured in the field during sampling included electrical conductivity (EC), pH, temperature and redox-potential. All portable meters were calibrated every day before sampling commenced. These samples collected were analyzed for all major cat-and anions including tracer elements (Appendix A).

The accuracy of the chemical analysis was calculated according to the plausibility of the electro neutrality (E.N.) error related field measurements i.e. pH, EC, O₂ and redox-potential readings. The electro neutrality is calculated using the following equation (in meq/l):

$$E.N. [\%] = \frac{\sum cations - \sum anions}{\sum cations + \sum anions} \cdot 100\% < 5$$

Concentrations below the limit of detection were ignored in the E.N. calculations. All E.N. values with error percentages above 10% were not included in the description.

The methods used for interpreting the geochemical characteristic of basement aquifers included a cluster analysis (multivariate statistical analysis), a mass balance method presented using Piper plots, rock source deduction, and weathering factors and reactions (ion ratio method). Each groundwater sample was characterized by major cations and anions as well as physical variables and stable natural isotopes making it a multivariable problem. Multivariable statistical analysis is a quantitative and independent approach to groundwater classification which groups groundwater samples and correlating chemical parameters (Cloutier et al, 2008). One such method, hierarchical cluster analysis, was used to interpret and characterize the groundwater samples. For this dissertation the hierarchical cluster analysis with Wards method forming clusters with Z-scoring was used. The classification of the samples into clusters is based on a visual observation of the dendrogram formulated using SPSS for Windows v.15.

3.1.3 Isotope method

The isotope method uses environmental tracers such as deuterium and oxygen 18, which are dissolved substances that are introduced into the water system by natural processes. This isotope method is able to trace water movement and sources of water over long time periods. According to Hiscock (2005) the radioactive isotope of water tritium (^3H) is useful in providing estimates of aquifer residence times. Isotopes like tritium can be used to determine the age of the water (dating technique).

As described by Hiscock (2005) and Kinzelbach (2002) rain water that recharges an aquifer comes from water that is evaporated over the oceans. Marine vapour is precipitated mostly over the ocean but the vapour that isn't is transported to higher latitudes and altitudes. After it reaches higher latitude and altitude the vapour cools down and condenses to form clouds. Part of the vapour is then brought through convection to the continent where it precipitates. The remaining vapour is precipitated as ice over the poles.

Within the water cycle ^2H and ^{18}O isotopes decrease in concentration. Compared with oceanic water, meteoric water (ground and surface water) is depleted in isotopes. The heavier isotopes will precipitate before the lighter isotopes causing depletion in isotopes. With continues precipitation events the rain water becomes increasingly isotopically depleted in water. The higher the latitude and altitude and the further away from the sea, the more precipitation events occur the more depleted in isotopes the rainwater will become.

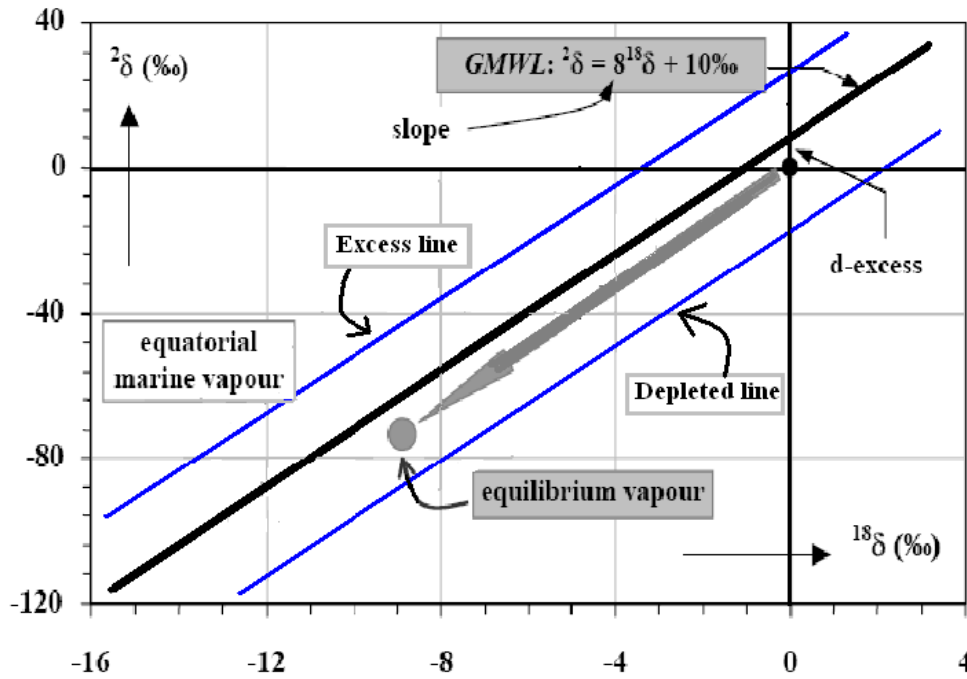


Figure 6: Schematic representation of isotope depletion (Source: Hiscock, 2005)

According to Hiscock (2005) and Kinzelbach (2002) as the evaporated water from the ocean reach isotopic equilibrium the vapour gets saturated with isotopes. With the first rain the remaining vapour becomes depleted in heavier isotopes like ^2H and ^{18}O . As this process continues the vapour becomes progressively depleted in isotopes. The isotope composition follows the black line representing the meteoric water line (GMWL) in Figure 6. The vapour that is depleted in isotopes follows the depleted line and vapour that has excess isotopes due to evaporation follows the excess line where it may move back to the gross meteoric water line (GMWL). The equation that represents the GMWL is as follows (Craig, 1961):

$$\delta^2\text{H} = 8\delta^{18}\text{O} + 10$$

With this the indication of mixing ratios, water origins can be analysed by comparing the heavier isotope concentration and amount of depletion with each other. (For water the accepted international standard is VSMOW (Vienna Standard Mean Oceanic Water) where ^2H and ^{18}O is equal to zero.)

The age of groundwater relates to the time when an aquifer experienced recharge and is a measurement of the groundwater residence time (Hiscock, 2005). A method for determining the age of the groundwater is through the concentration of the tritium isotope. According to Hiscock (2005) tritium (^3H), the radioisotope of hydrogen, has a half-life of 12.38 years and decays from the

mother isotope (^3H) into the stable daughter isotope ^3He . Tritium is produced naturally in the upper atmosphere by the interaction of cosmic ray produced neutrons with nitrogen. After oxidation to H_3HO , tritium becomes part of the hydrological cycle (Hiscoch, 2005). However, in the 1950's and 1960's nuclear bomb testing was conducted that increased the tritium levels in the atmosphere dramatically. Due to this, tritium is an ideal isotope to be used for age dating of groundwater that recharged after 1952. The use of tritium together with additional measurement of the helium (^3He), daughter isotope, can increase the accuracy of age dating.

Laboratory analysis of isotope samples deuterium (^2H) and oxygen (^{18}O) ratios were analysed at the Environmental Isotope Group (EIG) of iThemba Laboratories in Gauteng. The samples taken in the field were analysed in the laboratory using a PDZ Europa GEO 20-20 gas mass spectrometer. PDZ water equilibrium system (WES) was used to equilibrate oxygen and deuterium. It took an hour to equilibrate hydrogen (deuterium).

The results are presented in delta (δ) notation that is normally expressed in parts per thousand with respect to a known standard which is written as follows (Hiscock, 2005):

$$\delta = \left(\frac{R_{\text{sample}}}{R_{\text{standard}}} - 1 \right) 100\text{‰}$$

Where R_{sample} and R_{standard} are the isotopic ratios of the samples and standards respectively.

An increasing value of δ value indicates an increased proportion of heavier isotopes such as ^2H and ^{18}O . If the sample has a higher δ value it is said that the sample has a heavier, enriched isotope composition compared with another. The accepted international standard is VSMOW (Vienna Standard Mean Ocean Water) with δ values for Oxygen18 and deuterium equal to zero.

3.1.4 Evolution of groundwater composition

The supply of water is replenished by precipitation, which plays a major part in the occurrence of different water compositions. The supply of naturally occurring solid reactants is ultimately controlled by geological process. Only elements available in the rock mineralogy, which are in contacted with the water, can be expected to be in the final solution of the water chemistry. Sources of major ions are given in Table 3.

Table 3: Sources of major ions in water (Hounslow, 1995)

Major ions	Source	Reaction
Sodium (Na^+)	Halite, sea spray, hot springs, brines and some silicates, e.g. plagioclase, albite and nepheline.	Ion exchange $\rightarrow$ Na-montmorillonite clay reacts with Ca and Mg releasing Na
Potassium (K^+)	Potash feldspar, mica, leucite and sylvite.	Clay absorption
Calcium (Ca^{2+})	Calcite, aragonite, dolomite, gypsum, anhydrite, fluorite, plagioclase, pyroxene and amphibole.	Reverse ion exchange $\rightarrow$ natural softening
Magnesium (Mg^{2+})	Dolomite, ferromagnesian silicates e.g. olivine, pyroxene, amphibole and mica.	Reverse ion exchange or dedolomitization
Chloride (Cl^-)	Halite, sea spray, brines, hot springs, rainwater and evaporites.	
Sulfate (SO_4^{2-})	Pyrite, gypsum and anhydrite	Pyrite oxidation and sulphate reduction
Carbonate/Bicarbonate ($\text{CO}_3^{2-} / \text{HCO}_3^-$)	Rock weathering (atmospheric CO_2)	Rock dissolution, sulphate reduction, pyrite oxidation
Nitrate (NO_3^-)	Atmospheric gas, Agriculture and sewage	

Under the assumption of a long-term equilibrium, the groundwater chemistry of a region depends on the mineralogy of the subsurface and the chemical composition of rainwater and percolating water. The purpose of rock source deduction technique is to determine the possible sources or origins of a water signature. It is derived from a simplistic mass balance approach to water quality data based on the work of Garrels and MacKenzie (1967). The original composition of groundwater originates from rainfall, where the groundwater is altered by rock weathering; a certain amount of Ca^{2+} , Mg^{2+} , SO_4^{2-} , HCO_3^- and SiO_2 are added to the water depending on the mineralogy, and concentrations affected by processes such as evaporation and aeration.

By means of comparing cation and anions ratios and silica concentrations, potential mineralogical or rock sources can be derived for different groundwater chemistries. The following ratios will be used for rock-source deduction (Hounslow, 1995):

- Sodium (Na) and Chloride (Cl): By comparing sodium and chloride one can assume chloride in the water is derived from halite (NaCl) dissolution or from rainfall (oceanic signature). However, sodium can also be derived from sources such as dissolution of albite-plagioclase and be due to ion exchange processes. Thus if sodium equal chloride

concentrations (meq/l), halite dissolution is indicated and if sodium concentration is smaller than chloride concentration, reverse softening is indicated. However, if sodium concentration is greater than chloride concentration a source other than halite such as albite (plagioclase) or natural softening is indicated.

- Calcium (Ca) and Sulphate (SO_4): The primary assumption is that sulphate is generally derived from the dissolution of gypsum or the neutralization of acid water in limestone or dolomite. Thus, if the sulphate concentration is greater than the calcium concentration, then calcium has been removed from solution through calcite precipitation or ion exchange reactions. If the calcium concentration equals the sulphate concentration, gypsum is indicated as a source. However, if the calcium concentration is greater than the sulphate concentration, then calcite/dolomite or silicates are indicated as possible sources.
- Bicarbonate (HCO_3) and Silica (Si): Comparing bicarbonate and silica, bicarbonate (i.e. carbonates dissolve without releasing silica) and silicate weathering (albite releases considerable silica) as possible sources are evaluated. Bicarbonate will be less than or equal to silica if albite (i.e. plagioclase) is weathered, on the other hand if anorthite (plagioclase) is weathered no silica will be released. Thus, if bicarbonate concentrations are much greater than silica, carbonate weathering rather than silica weathering is indicated. Silicate and non-halite sodium ($\text{Na}+\text{K}-\text{Cl}$): Assuming after subtracting Cl the remaining sodium is due to weathering of albite (plagioclase) or ion exchange and the potassium is due to weathering of biotite and to a lesser extent potash feldspar. If other ferromagnesian minerals are present silica concentration will be in excess over potassium and sodium. Thus, if silica concentration is less than non-halite sodium concentrations, cation exchange is the source of the excess sodium. If silica concentration is greater than non-halite concentration, albite is likely to be the source with kaolinite or montmorillonite as the weathering products. However, if silica is greater than twice the amount of non-halite sodium, then the rocks subjected to weathering contain a large amount of ferromagnesian minerals, such as olivine, pyroxene or amphibole, usually indicating granitic weathering.
- Calcium (Ca) and Magnesium (Mg): If calcium to magnesium ratios approach one, it is likely that calcium was removed from the solution, through a process termed dedolomitization. If magnesium is greater than calcium, then dissolution of ferromagnesian minerals from mafic or ultramafic rocks (low TDS values) will be derived or sea water intrusion (high TDS values) is indicated.
- Sodium (Na) and Potassium (K): Even though both sodium and potassium may be produced in similar amounts by weathering of some igneous rocks, sodium tends to be

generally higher in concentration than potassium. When interpreting the source of potassium and sodium, the geology together with other rock source deduction ion ratios needs to be used to interpret the origin.

- Sodium (Na) and Calcium (Ca): Silicate weathering results in Na/Ca ratios of water similar to that of plagioclase from which it was derived. In carbonate weathering the Na/Ca ratio is very low unless considerable ion exchange has taken place. Thus the Na/Ca ratio can be used to determine silica or carbonate weathering.

The relationship between the major cations and bicarbonate produced during weathering of different rock types derived from molar ratios indicates another possible source for the ions in solution as tabulated in Table 4. The relationship between the ion ratios and the collected samples' ion ratio indicates the possible origin of the different cations in solution.

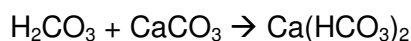
Table 4: Molar ratios for the weathering reactions for major cations and bicarbonate (Appelo and Postma, 1994)

Silicate Minerals	Ions	Molar Ratios
Albite to Kaolinite	$\text{Na}^+ : \text{HCO}_3^-$	1 : 1
Anorthite to Kaolinite	$\text{Ca}^{2+} : \text{HCO}_3^-$	1 : 2
Augite to Kaolinite	$\text{Ca}^{2+} : \text{HCO}_3^-$	1 : 3.7
Augite to Kaolinite	$\text{Mg}^{2+} : \text{HCO}_3^-$	1 : 4.3
Pyroxene to Kaolinite	$\text{Ca}^{2+} : \text{Mg}^{2+}$	1 : 0.7
Biotite to Kaolinite	$\text{K}^+ : \text{Mg}^{2+}$	1 : 2
Olivine (Forsterite) dissociation	$\text{Mg}^{2+} : \text{HCO}_3^-$	1 : 2

An addition to the ion related weathering processes another type of solution weathering process named carbonation, the process in which the atmospheric carbon dioxide lead to solution weathering, contribute to the weathering processes. This takes place when the rain combines with carbon dioxide and/or organic acids to form a weak carbonic acid which reacts calcium to form calcium bicarbonate. The reactions are as follow:



Carbon dioxide + water → carbonic acid



Carbonic acid + calcium carbonate → calcium bicarbonate

3.1.5 X-ray defraction and X-Ray fluorescence

The samples collected throughout the two focus areas were prepared for XRD analysis using a back loading preparation method. They were analysed with a PANalytical X'Pert Pro powder diffractometer with X'Celerator detector and variable divergence- and receiving slits with Fe filtered Co-K α radiation. The phases were identified using X'Pert Highscore and computer software. The relative phase amounts (weight %) were estimated using the Rietveld method (Autoquan Program). Amorphous phases were not taken into consideration in the quantification.

The same samples were also used for XRF ground to <75 μ m in a Tungsten Carbide milling vessel, roasted at 1000°C to determine 'Loss On Ignition' values and after adding 1g sample to 9g Li₂B₄O₇ fused into a glass bead. Major element analysis was executed on the fused bead using the ARL9400XP+ spectrometer. Another aliquot of the sample was pressed in a powder briquette for trace element analyses. Results for elements should be considered semi-quantitative. Blank and certified reference materials were analysed with each batch of samples.

3.1.6 Groundwater levels and flow vectors

All measured groundwater levels retrieved from the NGDB/NGA (maintained by the Department of Water Affairs) together with own measurements of water levels captured in the hydrocensus and from the GRIP II data base were used to compile a groundwater flow map with derived groundwater flow vectors. In general, (Figure 7) the water table is a subdued reflection of the topography, with a 99% level of assurance, where groundwater flow occurs from higher lying areas towards valleys.

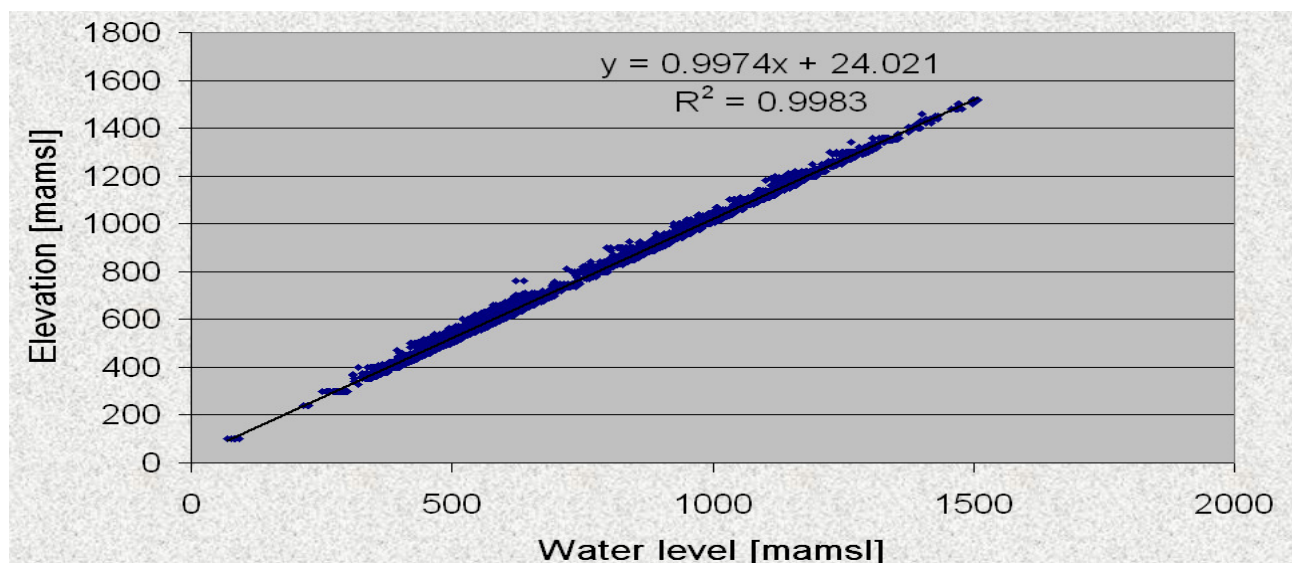


Figure 7: Elevation vs. Water levels in metres above mean sea level

The groundwater flow vectors assume a homogenous isotropic aquifer, i.e. don't consider structural anisotropy and heterogeneities of the underlying geology. . Precise groundwater flow paths are difficult to construct due to the borehole distributions, distances between the boreholes, lithostratigraphical units being either closed or open systems for groundwater flow, and unknown depths of the boreholes as well as influencing surface waters.

3.1.7 Groundwater recharge

High recharge rates contribute to groundwater signatures that represent fresh water. Everett et al. (1984) defined recharge to be the quantity of water flowing through the groundwater surface per unit time generally measured over a long time period. It represents the portion of rainfall that reaches the groundwater surface and is usually expressed as a percentage of the mean annual rainfall. According to Bredenkamp (1993), recharge of groundwater can be defined as the total recharge or input; precipitation and artificially, minus the losses that occur subsequent to infiltration in the unsaturated zone. In simple terms, it represents the portion of rainfall which reaches an aquifer, irrespective of whether it follows a preferential flow path via fractures, drains, through column of soil or infiltration from water in rivers and channel or local surface depressions. Despite the complexity of hydrogeological processes which include evapotranspiration, infiltration and run off, a simplified recharge equation can be constructed (Bredenkamp, 1993).

$$RE_{tot} = Rf - Ro - ET_{unsat} - SMD$$

Where RE_{tot} is the recharge, Rf is the rainfall, Ro is run-off, ET_{unsat} is the evapotranspiration in the unsaturated zone and SMD is the soil moisture flux

Chloride-rich water originates from oceanic vapour (as well as various geological units) which is transported from the sea and blown over land. Its concentration is directly influenced by the total distance that the vapour has travelled from the sea, or altitude and latitude. With each precipitation event, the chloride in the water or air is depleted, causing a decrease in chloride concentrations from the sea inland. Chloride is not lost to evaporation, thus the ratio of chloride in the rainwater in relation to that of percolating water represents the fraction of precipitation that forms the recharge.

4 PHYSIOGRAPHY

4.1 LOCALITY

The area of investigation falls within two water management areas (WMA), i.e. the Limpopo WMA (WMA1) and the Letaba\Luvuvhu WMA (WMA2), as seen in

Figure 8, both forming part of the Limpopo Province in the northern part of the Republic of South Africa. Due to the large extent of basement rock cover, two focus areas were identified according to the change in climatic conditions, geological diversity and available data for the areas. The primary focus area within the Limpopo WMA includes quaternary catchments A62E, A62F, A62H, A71E and A72A. The selected quaternary catchments extend roughly 40km from Polokwane northwards to Vivo (~120km north of Polokwane), covering an area of approximately 4300 km². The second focus area falls within the Letaba\Luvuhu WMA and includes quaternary catchments B82D, B82F and A91C. Geographically the area is located 25km east of Louis Trichardt and 30 km north of Duiwelskloof, covering an area of approximately 1600 km². The major rivers flowing through the two focus areas are the Hout, Seepabana and Matlalané Rivers in WMA 1 and the Letaba and Soeketse rivers in WMA 2.

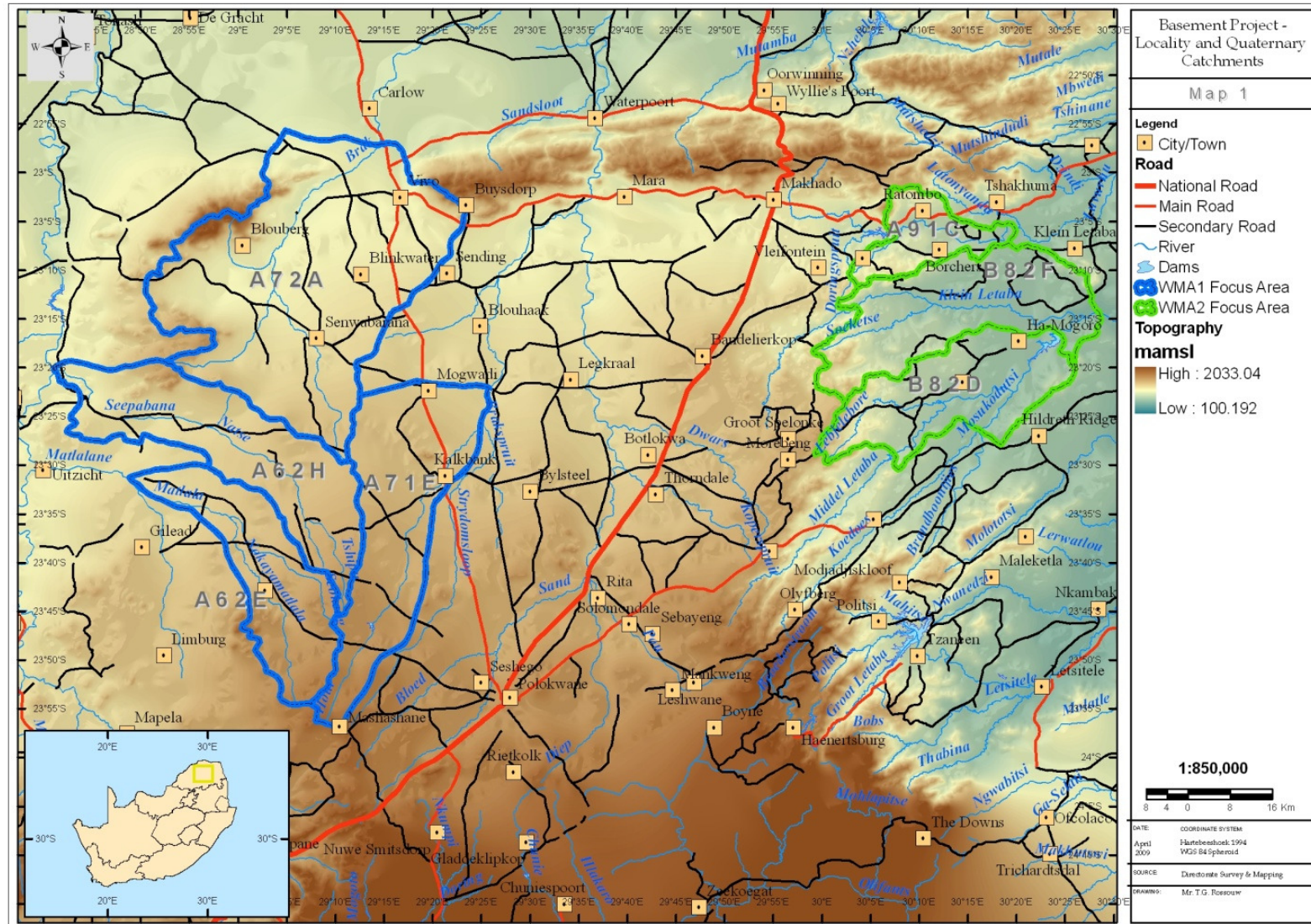


Figure 8: Locality and quaternary catchment map for WMA1 and WMA2

4.2 GEOMORPHOLOGY

The geomorphological features found in the research area are the result of the geological evolution of the Swazian aged Greenstone belts and granites forming the Kaapvaal Craton, collision between the Kaapvaal and Zimbabwean cratons forming the Limpopo Mobile Belt, granite and basaltic intrusions, sedimentary deposition forming the Blouberg, Waterberg and Soutpansberg formations together with the changing climate and the African erosion surface. Weathering and erosion influenced by the underlying geology also results in geomorphological features.

WMA 1 is characterised mostly by a flat lying terrain with an elevation of approximately 800 mamsl. Local granitic inselbergs occur due to more resistant Matlala, Mashashane and Moletsi granite intrusions, characterizing elevated areas of approximately 1300 mamsl (Figure 9). These granite intrusions are found in the southern part of WMA 1. Towards the northwest the Blouberg Mountains, consisting of sedimentary rocks from the Waterberg and Blouberg Group, together with the western edge of the Soutpansberg, have elevations between of 1600 and 1700 mamsl, forming topographically high areas. Recharge zones are mainly derived from these elevated mountainous areas. In contrast to WMA 1, WMA 2 is characterised by hills and valleys with elevations ranging between 600 and 800 mamsl. The Soutpansberg in the north and the Tzaneen escarpment in the south of the focus area form large mountainous areas characterized by elevations of about 1400 mamsl. Localized recharge occurs within the valleys together with the recharge from the mountainous areas. The different geological units (to lesser extent) and rock types as well as the climate play a huge role in the formation of the terrain. WMA 1 is characterised by low rainfall forming shallow weathered soil profiles and flat lying areas, while WMA 2 is characterised by high rainfall forming deep weathered soil profiles and mountainous areas. Both WMA focus areas are drained by non-perennial rivers. These rivers and drainage orientations are mostly controlled by geological features and structures such as dykes and faults.

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The geomorphology of the two WMA focus areas is illustrated below with two cross sections (Figure 10 and Figure 11). The topographical cross section through WMA 1 and WMA 2 has been computed from a Digital Elevation Model (DEM). The cross sections are orientated in a North – South direction.

Cross Section A (WMA 1):

- In the north is the Blouberg Group consisting of sedimentary rock forms, forming a mountainous setting. Localized groundwater flow is in a southerly direction based on topographical gradient.
- From the north towards the south the topography is relatively flat and is underlain by the Hout River Gneiss. Semi-arid climate conditions dominate throughout the areas and are elevated towards the south.
- In the south a sudden increase in elevation occurs due to the Matlala granite intrusion which is more resistant to weathering forming a granite inselberg. The major groundwater flow direction is in a northern direction with localized variations due to granitic intrusions forming higher elevated areas.

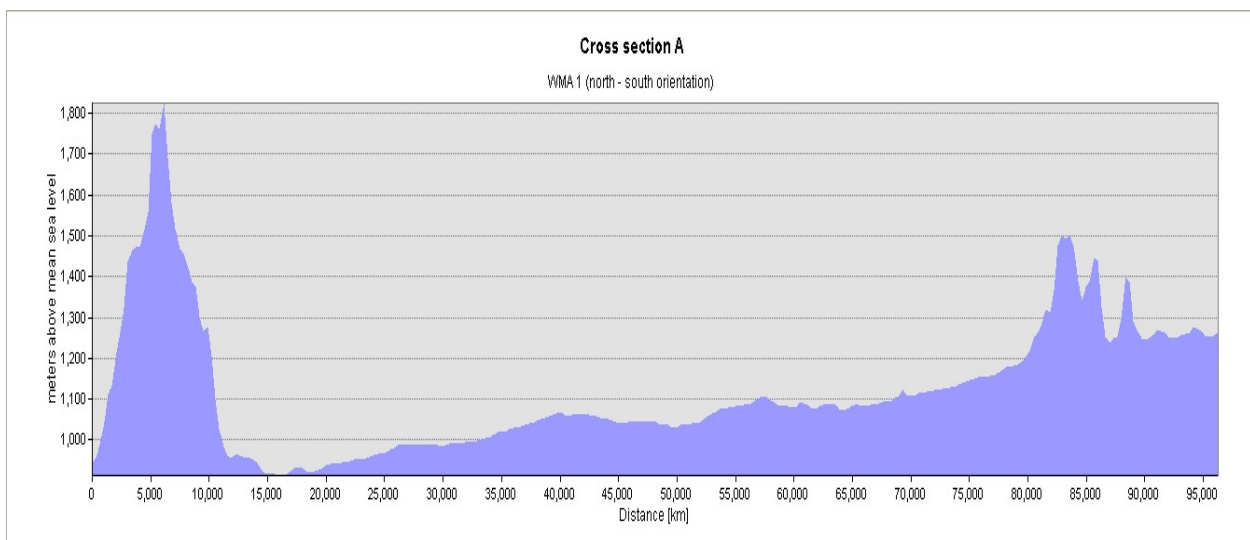


Figure 10: Cross section A for Limpopo WMA

Cross Section B (WMA 2):

- In the north highly elevated mountainous areas and deep valleys occur due to the formation of the Soutpansberg Mountain range consisting of sedimentary rocks and basaltic lavas. The Soutpansberg Mountain range results in orogenic rainfall conditions causing the area to receive high amounts of rainfall in the summer. It also acts as a major recharge area for the study area.

- Major parts of the study's focus area are characterized by hills and valleys underlain throughout by the Goudplaas gneiss. This is mainly due to the tropical climate conditions causing chemical weathering to form localized elevated areas.
- In the south the Tzaneen escarpment occurs consisting of mica rich granites. Groundwater flow is assumed to be in a northerly direction away from the elevated Tzaneen escarpment. However, the groundwater flow direction is predominantly in an easterly direction.

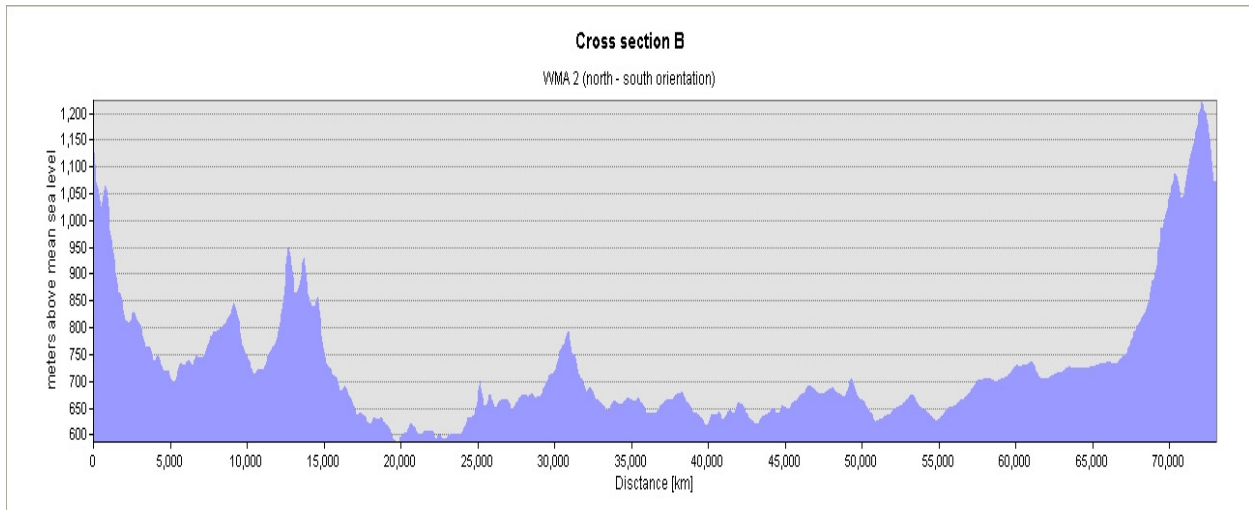


Figure 11: Cross section B for Letaba\Luvuvhu WMA

4.3 CLIMATE

The climate is typical of the South African Highveld, characterized by warm wet summer months between October and March with most of the rainfall occurring as thunder showers, and cool dry winters with cold nights and mist occurring. Some orogenic rainfall does occur in WMA 2 as the cloud area accreted onto the Soutpanberg and Tzaneen mountain range. The mean annual precipitation (seen in Figure 12) varies from 300 to 600 mm in WMA 1 with the greatest part of the study area receiving only 300 mm/annum. The Soutpansberg and Blouberg mountains experience precipitation of between 500 and 600 mm/annum. The mean annual precipitation for WMA 2 varies between 400 and 1000 mm. The area along the Soutpansberg and Tzaneen escarpment receives precipitation as high as 1000 mm/annum. Mean annual evapotranspiration (seen in Figure 13) for WMA1 is between 1700 and 2000 mm and for WMA2 is between 1400 and 1700 mm, exceeding more than half of the amount of rainfall. Different rainfall stations with their rainfall records are shown in Table 5.

Table 5: Climatic data for the study area

SAWS*	Rainfall record	Coordinates		Rainfall (mm/a)
		Latitude	Longitude	
Bandelierskop	1986-present	-23.32	29.8	408
Chloe-sisal project	1986-present	-23.65	29.07	329
Consolidated Murchison mine	1986-present	-23.9	30.7	496
Dendron	2001-present	-23.37	29.33	344
Elim Hospital	1986-2006	-23.17	30.05	669
Grenshoek Tzaneen	1997-present	-23.77	30.07	1120
Grootgeluk Mine	1986-present	-23.67	27.57	458
Haenertsburg	1986-present	-23.93	29.93	791
Hans Merensky Hoërskool	1986-present	-23.78	30.13	967
Kalkfontein	1986-1992	-23.9	29.58	403

*Data obtained from the South African Weather Service

4.4 VEGETATION

The vegetation (Low et al., 1996) of the research area seen in Figure 14 is mostly characterised by Bushveld biomes, which are dominated by *arid sweet bushveld*, *lowveld sour bushveld* and *mixed bushveld* with some *north eastern mountain sourveld* and *Pietersburg plateau grassveld*. These Bushveld biomes consist mostly of *Acacia* trees and *Hyparrhenia* grass with some *Mopane* and *mixed savannas*. The vegetation in the east (WMA 2) shows tropical conditions to some extent due to the high annual rainfall, whereas in the west (WMA 1) semi-arid conditions prevail.

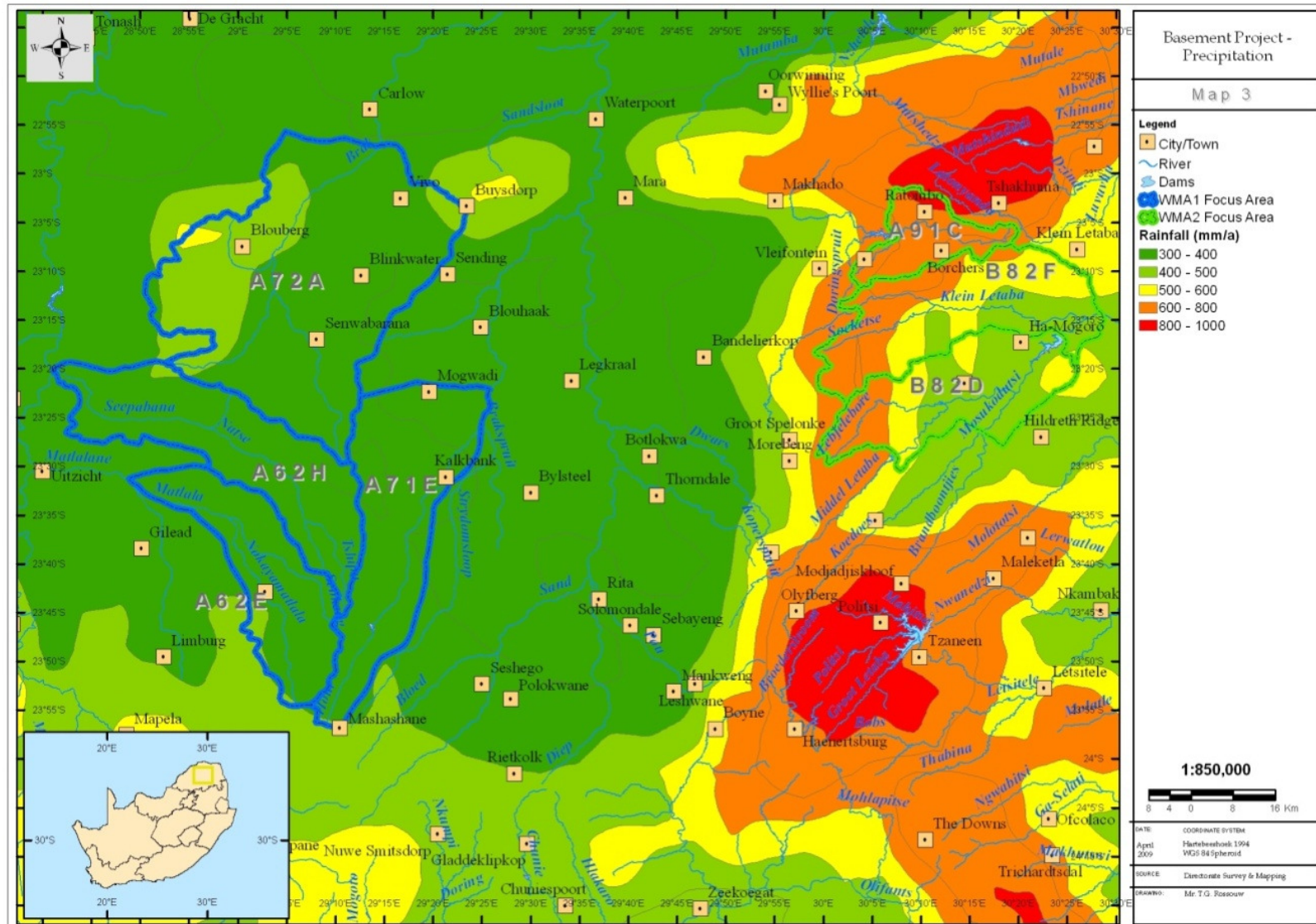


Figure 12: Mean annual precipitation for WMA1 and WMA2

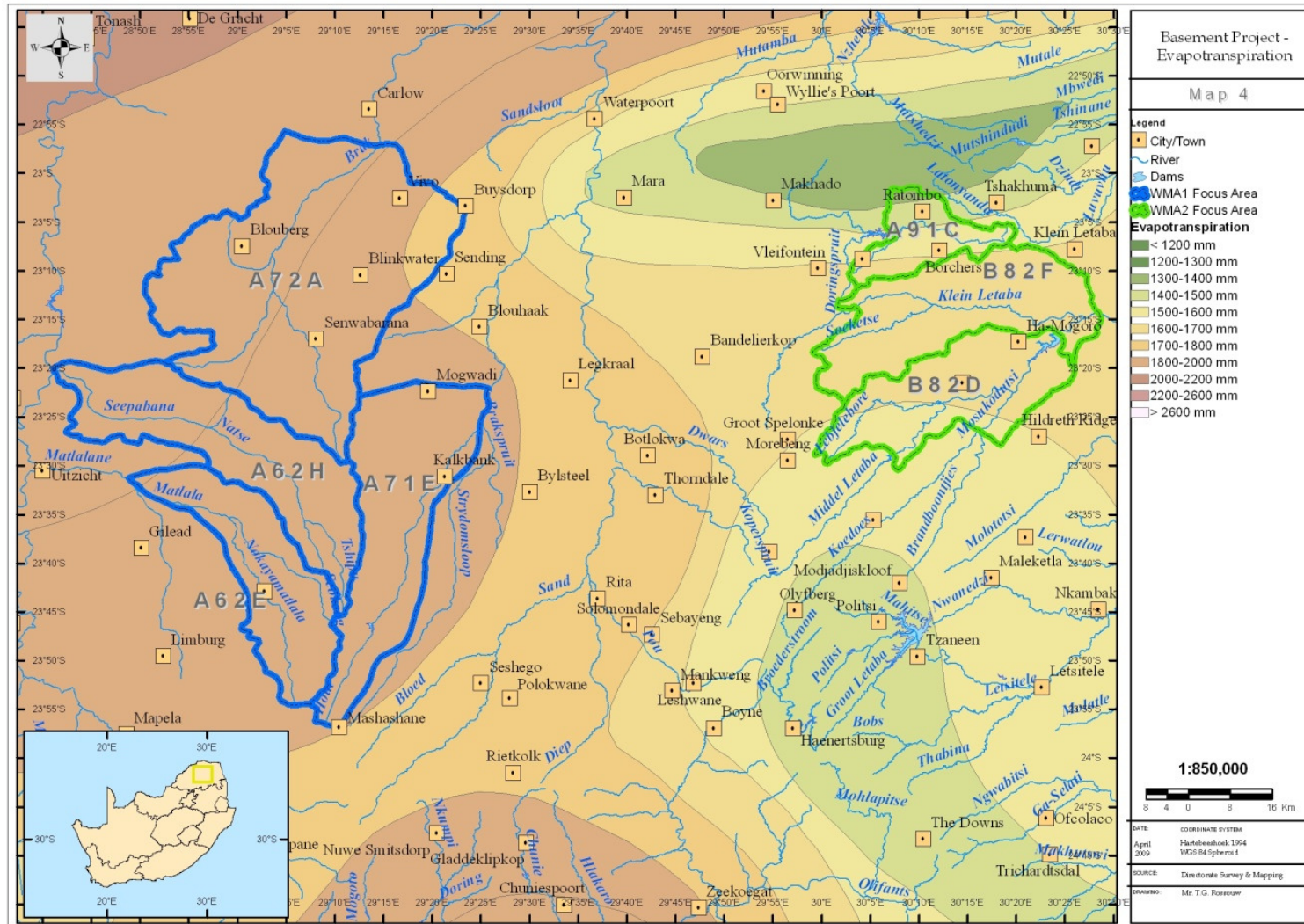


Figure 13: Mean annual evapotranspiration for WMA1 and WMA2

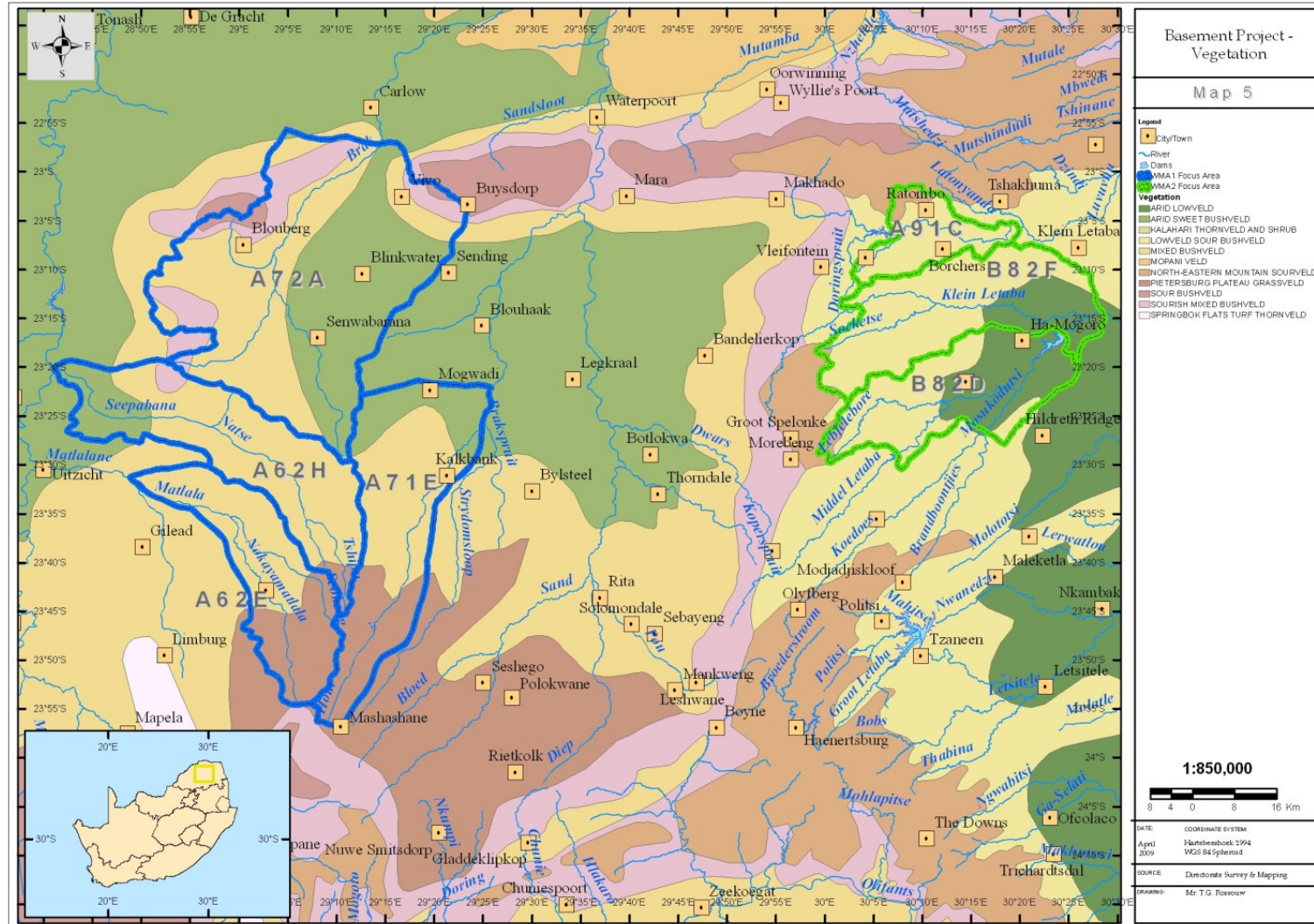


Figure 14: Vegetation map for WMA1 and WMA2

5 GEOLOGY

5.1 INTRODUCTION

The term Kalahari Craton was recently introduced (Johnson et al., 2006) for the discussion of the Kaapvaal and Zimbabwean Craton together with the Limpopo Mobile Belt (LMB), a gneissic zone, as a whole formational event describing the evolutionary stages of the Limpopo Mobile belt welded onto the stable Kaapvaal and Zimbabwean Craton creating a large stable region on which various geological events and features occurred. The evolution of Southern Africa can be regarded as a sequence of accretion onto the stable Kaapvaal Craton during both extensional and compressional tectonic periods (Patridge and Maud, 1987). With the occurrence of the accretion of the Limpopo Mobile Belt onto the Kaapvaal craton (approximately 3.1 Ga) and Zimbabwean Craton, the research area is characterized by granitoid-greenstone rock formations together with rocks of sedimentary and volcanic origin.

The study area falls within the southern marginal zone of the Limpopo Mobile belt in the north-eastern section of the Kaapvaal Craton and is mostly underlain by Precambrian crystalline basement rocks (granite, gneiss, greestones, etc.). The research area is delineated by the Bushveld Complex towards the west of WMA1, and the Waterberg, Blouberg and Soutpansberg group towards the north. Table 6 show the different geological units/formation present in the research area. Typical characterisation of the gneisses is that they are either fine grained to pegmatoidal, and homogenous or layered (Brandl, 1986, 1987; Du Toit et al., 1983; Anhaeusser, 1992; Brandl and Kröner, 1993). All these formations are consequently overlain by quaternary deposits formed from erosional sequences of the pre-existing formations.

Table 6: Lithostratigraphical units present in the research area with rock type and age

Era	Lithostratigraphical Units	Rock Types
Cenozoic (< 65 Ma)	Quaternary deposits	Sandstone, soil
Mokolian (2050 – 1000 Ma)	Blouberg Formation	Sandstone, feldspathic granulestone, breccias, conglomerate, quartzite and gneiss
	Waterberg Group	Granulestone, conglomerate and sandstone
	Soutpanberg Group	Basalt, andesite, shale, greywacke, conglomerate and lava
Vaalian (2650 – 2050 Ma)	Bushveld Igneous Complex	Gabbro norite
Swazian (> 3100 Ma)	Archaean Granitoid Intrusions	Granitic rock
	Archaean Greenstone Belts	Gneiss, schist, quart-carbonate rock, amphibolites, komatiite and basalt
	Goudplaats-and Houtriver gneiss	Gneiss

5.2 KAAPVAAL CRATON

The study area falls within the north-eastern part of the Kaapvaal Craton characterized by the widespread occurrence of the Goudplaats and Hout River Gneiss suites consisting of various types and compositions of granitoid gneisses. Figure 15 shows the different rock types found in and around the study area. The granitoid gneisses range from homogenous to strongly layered, from leucocratic to dark-grey and from fine-grained to pegmatitic (Brandl, 1986, 1987; Du Toit et al., 1983; Anhaeusser, 1992; Brandl and Kröner, 1993). Initial separation of the continental lithosphere from the mantle was followed by tectonic accretion of crustal fragments achieving growth of the craton, which eventually stabilized approximately 3.7 – 2.7 Ga (De Witt et al., 1992). Accretion and growth of the craton took place onto the northern edge of the Kaapvaal Craton, causing deformation within the basement lithology indicating that the northern domain is younger than the eastern domain (Poujol et al. 2003). In addition, the northern domain of the craton experienced magmatic activity during neo-Archaean times, which included intrusions of large post-tectonic granitoids in the Polokwane/Pietersburg and Murchison areas (Poujol et al., 2003).

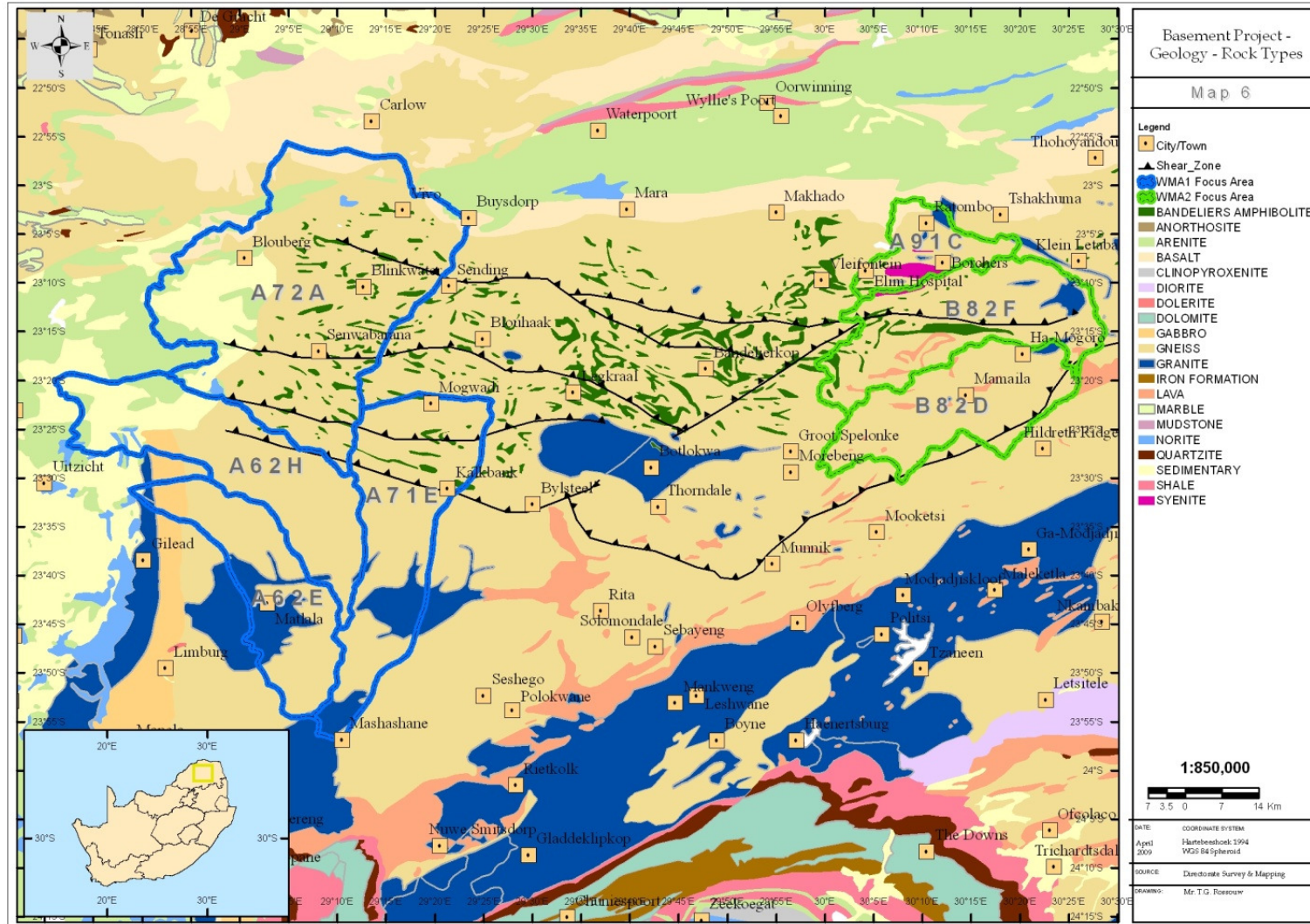


Figure 15: Geological map according to rock types for WMA1 and WMA2

5.2.1 Limpopo Mobile Belt

The Limpopo Mobile Belt formed through a continental-continental collision orogeny between the Kaapvaal and Zimbabwean Cratons, and forms part of the Kalahari Craton. Characterized by a granulite grade metamorphic belt trending ENE and stretching approximately 550km with a width of 250km (Bumby et al, 2004), the Limpopo Mobile Belt consists of three zones, the Northern Marginal Zone, Central Zone and the Southern Marginal Zone lying parallel to each other in a ENE trending direction. The Northern Marginal Zone represents the metamorphosed southern part of the Zimbabwean Craton bound in the north by the northern marginal shear zone and the Triangle and Mogogaphate shear zones in the south separating the Northern Marginal Zone and the Central Zone. The southern boundary of the Central Zone is formed by the Palala shear zone and Tsipise Straightening zone dipping north. According to McCourt and Vearncombe (1987), the Triangle and Palala shear zone have dextral and sinistral senses of shear suggesting that the Central Zone may be a westwards verging nappe. South of the Palala shear zone is the Southern Marginal Zone, which is bound by the Hout River shear zone. The study area is located in the north-eastern Kaapvaal Craton within the Southern Marginal Zone including part of the Hout River Shear Zone.

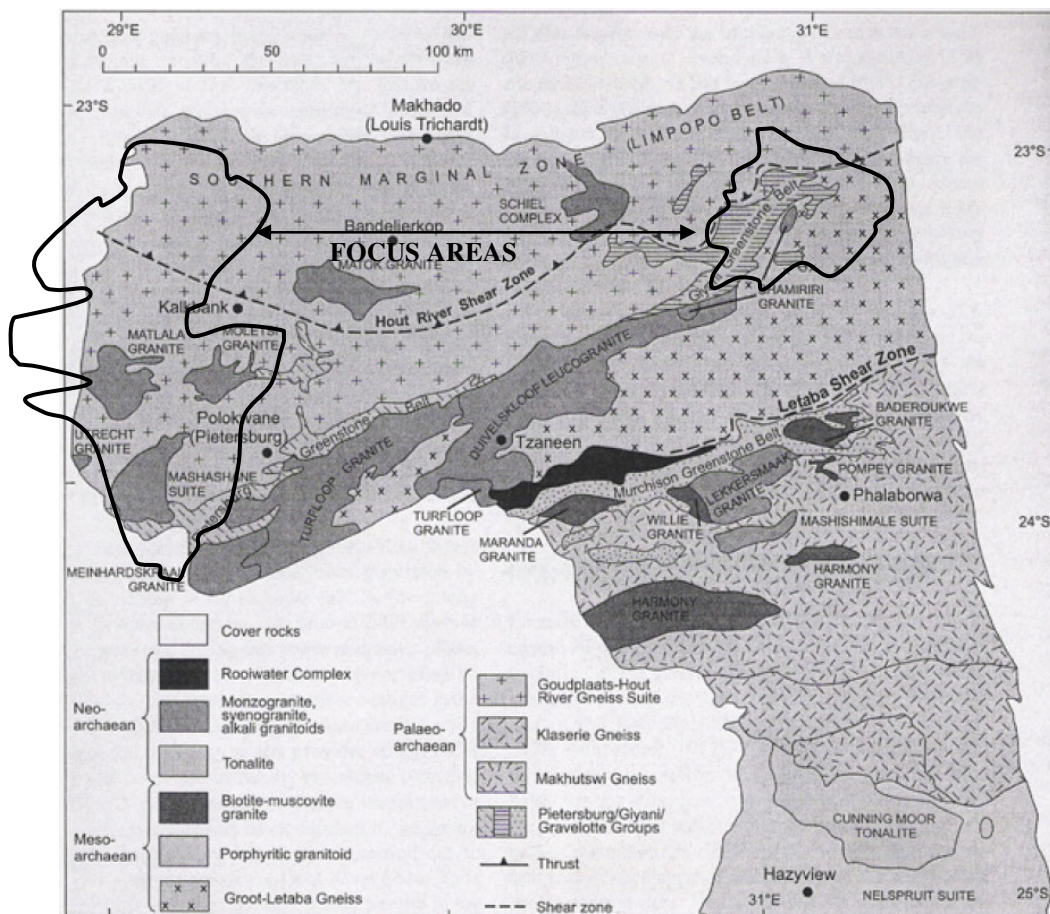


Figure 16: Map of the northern and north-eastern sectors of the Kaapvaal Craton and their different granitoid occurrences (from Robb, et al., 2006)

5.2.2 Goudplaats- and Hout River gneiss

The leucocratic, strongly migmatized Hout River gneiss and grey, layered less well migmatized Goudplaats gneiss (shown in Figure 16) show a typically flat topography with poor exposure. In the Polokwane area within WMA1 the suite consists of homogenous, light-grey medium grained biotite gneiss containing some greenstone material. In the vicinity of the intruded Moletsi and Matlala granites, two gneiss varieties are found; a grey, migmatitic biotite gneiss which is intruded by homogenous light grey non-migmatitic biotite gneiss (Brandl, 1985). In the Kalkbank area, 50 km north of Polokwane, coarse grained to pegmatoidal leucocratic gneiss consisting of very little biotite with some greenstone belt material is found. In the Bandelierskop area, 80 km northeast of Polokwane, greyish migmatitic gneiss and leucocratic granite characterise the area. The gneiss is well layered with various degrees of migmatization, showing a granitic composition consisting of oligoclase, quartz, alkali-feldspar, biotite and minor hornblende. According to Robb et al. (2006), the granite has been generated from fluid absent dehydration melting of biotite gneiss under granite grade conditions. The Goudplaats gneiss, characterised by light to dark grey gneisses together with minor leucocratic gneisses, hornblende amphibolites and hornblende-biotite tonalitic gneiss, is complexly folded. The greyish gneisses are composed of plagioclase, quartz, minor alkali-feldspar with biotite and hornblende present in various proportions. The Goudplaats gneiss has been dated at 3333 Ma (Brandl and Kroner, 1993). In most of the area around the Giyani Greenstone Belt in the eastern part of WMA2 a medium grained, whitish or pinkish leucocratic gneiss with light to dark grey layered gneiss composed of plagioclase, alkali-feldspar, minor biotite with hornblende and oligoclase is found.

5.2.3 Archaean Greenstone belt

Four significant greenstone belts occur in the northern and northeastern sector of the Kaapvaal Craton; the Rhenosterkoppies, Pietersburg, Giyani and Murchison greenstone belts. The Rhenosterkoppies Greenstone Belt is found 30 km north of Polokwane, marking the boundary between the Southern Marginal Zone and the Kaapvaal Craton, as it is found next to the Hout River Shear Zone. The greenstone belt consists almost entirely of migmatitic gneiss together with mixed mafic and ultramafic rocks. The mafic rocks are represented by fine to coarse grained amphibolites and quartz and sometimes include hornblende, pyroxene, plagioclase and diopside. The ultramafic rocks are characterized by a schistose appearance consisting of talc, chlorite, tremolite, olivine and anthophyllite. The Rhenosterkoppies Greenstone Belt was reported by Passeraub et al. (1999) with an age of 2950 – 3100 Ma.

The Pietersburg Greenstone Belt is found around Polokwane south and south east of WMA1 comprising of basal sequence of volcanic rocks overlain unconformably by the sedimentary

Uitkyk formation. The Pietersburg Greenstone Belt is characterized by granodioritic and tonalitic gneiss with various compositional granitoids. The ultramafic rocks consist of massive well foliated serpentinite, talc-carbonate schists and quartz-carbonate rocks southwest of Polokwane. Northeast of Polokwane mafic rocks are well foliated, fine grained actinolite- or hornblende-bearing amphibolites. Robb et al (2006) and Kröner (2000) aged the Pietersburg group to be between 2940 and 2870 Ma.

The Giyani Greenstone Belt is almost completely enveloped by magmatic gneiss (Vorster, 1979) dominated by ultramafic and to a lesser extend mafic rocks. Metavolcanic ultramafic-mafic rocks characterise the Giyani Greenstone belt consisting of schistose komatiite, komatiite basalts and tholeiitic basalts together with massive sill-like intrusive bodies (Van Zyl et al., 1942; Prinsloo, 1977; Vorster, 1979; Anhaeusser, 1981). The ultramafic rocks consist of tremolite, talc, chlorite and/or hornblende, a typical greenstone belt rock composition. Resistant quartz-sericite schist derived from altered felsic volcanic rocks giving rise to prominent ridges is found in the investigated area. According to Brandl and Kroner (1993) and Kroner et al. (2000) the Giyani Greenstone Belt is dated approximately to 3200 to 2800 Ma.

The Murchison Greenstone Belt found southeast of Tzaneen and south of the WMA2 with its Rooiwater Complex is surrounded by tonalitic and trondhjemitic gneisses and late stage granitic plutons. Vearncombe et al. (1992) inferred that the Murchison Greenstone Belt is the deformed remnant of five distinct domains that have been tectonically added. The Murchison Greenstone Belt is bounded by granitic gneisses, migmatites and pegmatites. Dating of the Murchison Greenstone Belt revealed an age of 3090-2970 Ma (Brandl et al., 1996; Poujol et al., 1996). Gneisses found in and around the greenstone belt are generally migmatized with leucosome bands belonging to distinct generations of magma.

The Pietersburg and Giyani granite-greenstone belts extend parallel to the southern part of the Southern Marginal Zone of the Limpopo belt separated by intensely migmatized rock. Kröner et al. (2000) regard the Giyani and Pietersburg granite-greenstone belts as two separate crustal units, which were originally in close proximity to one another, but were later displaced by strike-slip movement. However, Anhaeusser (1992) suggested that the Pietersburg and Giyani granite-greenstone belt are part of the belt. The 3.2 Ga Giyani greenstone belt trends ENE, the same as the Pietersburg greenstone belt, and is surrounded by pre-3.2 Ga polydeformed gneisses (Kröner et al. 2000). The Kaapvaal Craton also consists of various other Paleoproterozoic intrusions (3600 – 3200 Ma) such as the Goudplaats-Hout River gneiss suite consisting of granitoid gneiss found north and south of the Hout River Shear zone. The phases forming part of the Goudplaats-Hout River gneiss suite with an age around 2900 Ma generated by dehydration melting of amphibolites and biotite gneiss pervade an older granitoid crust (3300 Ma) suggesting that the older granitoids served as a basement for the greenstone belts. All these greenstone belts are characterised by

quartz-sericite schists, chloride schists, quartzite, amphibolites and/or lavas together with iron formation deposits.

Within the South Marginal Zone of the Limpopo Belt a number of pod-like ultramafic bodies which are high grade metamorphosed rock equivalents of Archaean greenstone belt lithologies are found (Du Toit, 1979; Du Toit et al, 1983). These MgO-rich rocks consist of peridotite, pyroxenite, dunite and hornblend (Van Schalkwyk, 1991, 1992; Brandel and De Wit, 1997). These rocks have been dated by Barton et al. (1992) to be approximately 2665 Ma old.

5.2.4 Archaean granitoid intrusions

Large post-tectonic granitoid magmatic activity occurred, emplacing massive, unfoliated granites occurring as batholiths, plutons and stocks in the Pietersburg and Murchison areas. These granitic intrusions form prominent topographical features that can be seen north of Polokwane. Within the Polokwane area, the Turfloop Granite forms elongated northeast trending batholiths. In general the Turfloop Granite intrusion is metaluminous to slightly peraluminous in character. The Turfloop Granite runs roughly NE-SW along the southern border of the Pietersburg Greenstone Belt and ranges in composition from granodioritic to monzogranitic, which might be an indication that it is composed of a number of smaller plutons (Henderson et al., 2000; Kröner et al., 2000). According to Henderson et al. (2000) and Kröner et al. (2000) the age of Turfloop Granites dates between 2777 and 2674 Ma old. At the southwestern end of the Pietersburg Greenstone Belt the Mashashane Suite batholith intruded the Goudplaats-Houtriver Gneiss Suite. The Mashashane Suite consists of three distinct phases, called the Lunsklip, Uitloop and Uitvlugt Granites (Brandl, 1985 and 1986). All three of these phases contain blue opalescent quartz (De Villiers and Brandl, 1977). The Matlala Granite occurs north of Polokwane falling within the WMA1. It is a circular shaped batholith comprising of fine grained pink granite and medium grained to porphyritic pink granite. The Matlala Granite is interpreted as representing the earliest phase of a batholith consisting of abundant biotite. The Moletsi Granite located east of the Matlala Granite consists of three phases (Brandl, 1985, 1986). A coarse grained pinkish to pink-grey granite occur in the core of the body, surrounded by a younger grey, coarse grained to porphyritic granite. A minor early phase is represented by medium to fine grained, dark grey, tonalitic granite. In some places narrow dykes of grey monzogranite and pink, leucogranite cut the granite intrusion. The Matoks Granite is unique from the other granite intrusions as it consists of orthopyroxene-bearing rocks. Barton et al. (1992) date the rock to be between 2663 and 2666 Ma. The Duiwelskloof Leucogranite forms a large batholiths intrusion that extends from south of Giyani Greenstone Belt towards the west (Brandl, 1987). The leucogranite is an off white, medium grained rock which locally grade into a pegmatiodal irregular mass. The Duiwelskloof Leucogranite is a large, northeast trending; elongated intrusion that stretches from the southeastern boundary of the Giyani Greenstone Belt to

the Turfloop Granite. The Palmietfontein Granite magmatic event is described to be the youngest granitic rock present in the basement complex (Du Toit, 1979; Du Toit et al., 1983). These granitic rocks represent an age between 2456 Ma (Barton et al., 1983) are medium to fine, pinkish grey granodiorites.

5.3 DIABASE DYKES AND SILLS

A large number of diabase dykes and sills are found throughout the study area. Dyke swarms outcrop more densely in the north-eastern domain of the Kaapvaal than elsewhere on the craton and northeast-trending diabase dykes are dominant in the study area. Due to their orientation and age, these northeast-trending dykes are associated with 2.7 Ga Ventersdorp Supergroup trends (Uken & Watkeys, 1997), which formed either in response to the Limpopo orogeny (Burke et al., 1985) or by crustal extension due to mantle plume activity (Hatton, 1995). Later Karoo dolerites sporadically cut through the older dykes, but usually follow the same intrusion paths as their Archaean predecessors. The Houtrivier Shear Zone was probably one of the controls of the dyke emplacement in the area, because many more dykes are observed north of the Hout River Shear Zone (in the South Marginal Zone) than south of it. One should not only consider the orientation of the dykes, but also their thickness. According to Bromley et al. (1994) pumping tests in Botswana revealed that dolerite dykes thicker than 10m serve as groundwater barriers, though those that are narrower tend to be permeable due to the fact that cooling joints and fractures are developed in them.

5.4 BUSHVELD COMPLEX

The western edge of WMA1 is bounded by the northern limb of the Bushveld Complex. This intrusive complex is intruded into basement rocks and comprises of the lower Rustenburg Layered Suite and the Lebowa Granite Suite above. The layered rocks of the Bushveld Complex are believed to be the result of slow cooling during crystallization (gravitational crystals settling) of magma. Bowen (1928) described these as accumulative rocks. These accumulative rocks consists of two classes of materials; cumulus grains that form from settling and become packed and intercumulus liquid filling up the spaces between the cumulus grains that cements them together (Jackson, 1967). These rocks are characterised by large homogenous rocks with igneous lamination. The formation of the rocks in the Bushveld Intrusive Complex is formed through the processes of fractional crystallization and mineralization in a magma chamber, which follows Bowen's reaction series. Gabbro Norite rocks characterise the western edge of WMA1 within the Bushveld Complex.

5.5 SOUTPANSBERG, WATERBERG AND BLOUBERG FORMATION

The Soutpansberg formation is located north of both WMA 1 and WMA2, forming a large east-west trending mountain range. The Blouberg and Waterberg formation are located northwest of WMA1, where they form local recharge areas. The Soutpansberg, Waterberg and Blouberg formations are considered to be between 1700 and 2000 Ma old, forming part of the Palaeoproterozoic age (Barker et al., 2006).

The Blouberg Formation consists completely of clastic sedimentary rocks deposited nonconformably over the granulite-grade gneisses of the Limpopo Mobile Belt with a maximum thickness of 1400m (Jansen, 1975; Bumby et al., 2001a). However, only sequences of less than 300 metres are found at outcrop. The Blouberg formation consists of two members, a lower and upper member. The 600 metre thick lower member consists of cross-bedded coarse arkosic sandstone and channel fills of feldspathic granulestone (Wentworth, 1922) in association with depositional events in braided river and stream systems. The upper member consists of coarse, feldspathic sedimentary breccia and conglomerate. The cobbles and boulders consist of quartzite and foliated feldspathic gneiss. The formation event of this upper layer is interpreted as the deposition of alluvial fans. The sediments of the Blouberg Formation are characterised by overturned sediments with steeply dipping bedding planes dipping in a northerly direction (Bumby et al., 2001a). However, the lower member of the formation is characterised by southwards dipping planes. The sandstones are often feldspathic, consisting of subangular grains of quartz with minor K-feldspar and opaque minerals. Relatively high potash values (1.2-2.0 wt%) are due to the presence of feldspar in the sediments.

The Soutpansberg Formation rests unconformably on the Archaean granulite-grade gneiss as well as on the Blouberg formation with a maximum thickness of 5000 m (Barker, 1979 and Brandl, 1999). According to Barker (1979) the Soutpansberg formation comprises of both volcanic basalt and andesites (Barker, 1981; Barton, 1979; Crow and Condie, 1990; Bumby, 2000; Brandl, unpublished data) and sedimentary rock successions that is subdivided onto six successions. The Waterberg Group similarly outcrops along the north-western margin of WMA1, and consists of the Setlaole, Makgabeng and Mogalakwena formations. The basal Setlaole Formation rests nonconformably on basement rocks, and is composed of coarse granulestone and is locally conglomeratic. This formation is interpreted to have been deposited in a fluvial, braided river environment. The Makgabeng Formation was likely to have been deposited conformably on the Setlaole Formation, and consists of large-scale trough and planar cross-bedded fine- to medium-grained sandstone, which is interpreted as an aeolianite (Bumby, 2000). The Mogalakwena Formation, in contrast, lies disconformably above the Makgabeng Formation, and further to the north rests on the Blouberg Formation on a sharp angular unconformity. These strata consist of

interbedded sheets of granulestone and conglomerate in proximal areas, grading into trough cross-bedded granulestones and sandstones in distal areas to the SW (Bumby, 2000).

6 GEOCHEMICAL CHARACTERISTICS

This chapter presents an interpretation of the groundwater chemistry in both WMA 1 and WMA 2. The major cations and anions and isotopes are discussed for each focus area, and the two areas are compared to each other. Characterizing the groundwater composition also allowed discussion of the groundwater composition and possible groundwater evolution within different geological units.

6.1 GROUNDWATER COMPOSITION CHARACTERISTICS

An overview of the descriptive statistics of the physical and chemical parameters as well as the isotope analysis will be presented. The data retrieved from the two WMA's will then be discussed and compared to see if there is any correlation and if not what the possible explanation(s) is (are). The borehole distribution plotted on the geological map can be seen in Figure 17

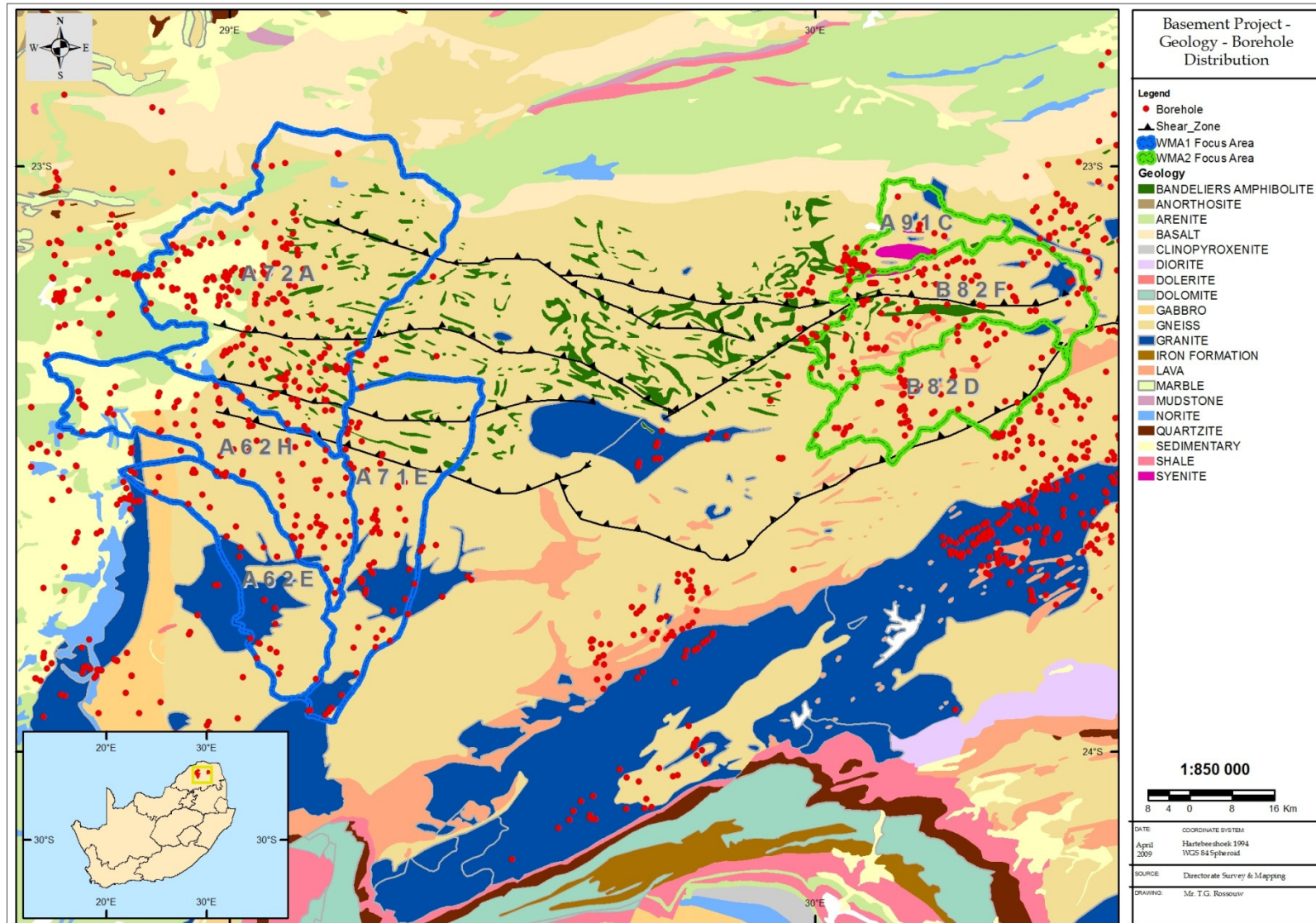


Figure 17: Borehole distribution of analyzed boreholes and geological formation

6.1.1 WMA1

The frequency bar charts (Figure 19 and Figure 20) used for the results of the geochemical characteristics illustrates the most frequently observed ions. Both pH and EC show very high concentration values for the Turfloop granites and very low concentration values for Bandeliers Complex. The mean concentration for silicate according to the different geological units shows very high values for all except Bandeliers Complex, Diabase intrusions and Lunsclip granites.

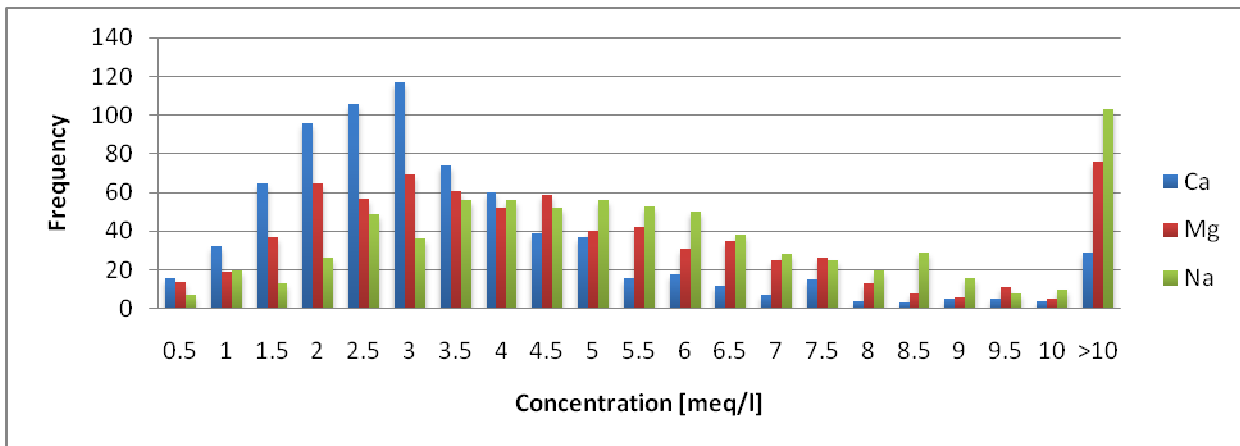


Figure 18: Frequency distribution of major cation concentration for WMA1

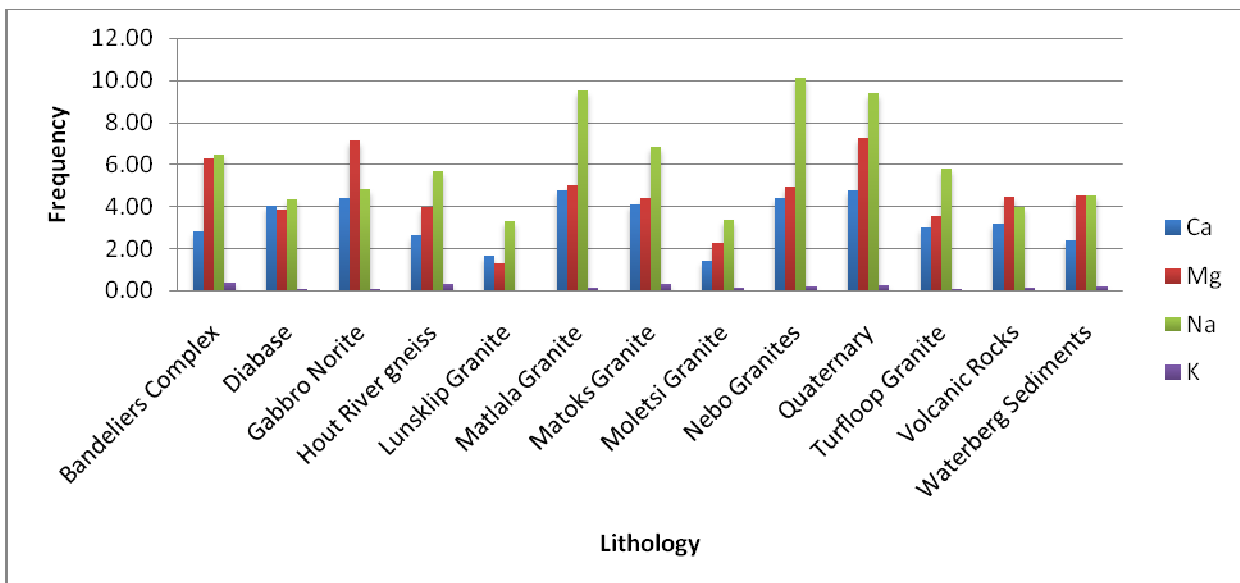


Figure 19: Average major cation concentrations (meq/l) versus lithology for WMA1 focus area

The calcium (Ca) and magnesium (Mg) frequency distributions for WMA1 show generally positively skewed distribution, while the sodium (Na) distribution resembles except for the large number of extremely high Na concentrations a normal distribution. Essentially Ca dominates the lower cation concentrations and Mg and Na the lighter cation concentrations. This can be explained by Ca

being exchanged with Mg (cation exchange reactions) adding Mg and removing Ca from the solution or calcium precipitating from the system as calcrete or a cementation agent. The highest measured cation concentrations are 657 mg/l for Ca, 52 mg/l for Mg and 3286 mg/l for Na. The frequency charts for the major cations in relation to the rock types, show very high concentration values for Matlala, Matoks and Nebo granites as well as for quaternary deposits. Relatively low concentrations are recorded for the Lunsklip and Moletsi granites, volcanic rocks and diabase. The Matlala, Matoks and Nebo granites show elevated Na concentrations compared to the other cation concentrations. The Na sources can be related to plagioclase weathering, releasing sodium into the groundwater system. In the granitic intrusions (the Turfloop, Lunsklip, Matlala, Moletsi and Nebo granites) sodium (Na) appears as the dominant cation, most probably a result of cation exchange with potassium (K), which is released during the weathering of these rocks. Diabase and volcanic rocks show almost balanced cation ratios of calcium, while magnesium and sodium dominate in the Bandeliers Complex and Waterberg sediments.

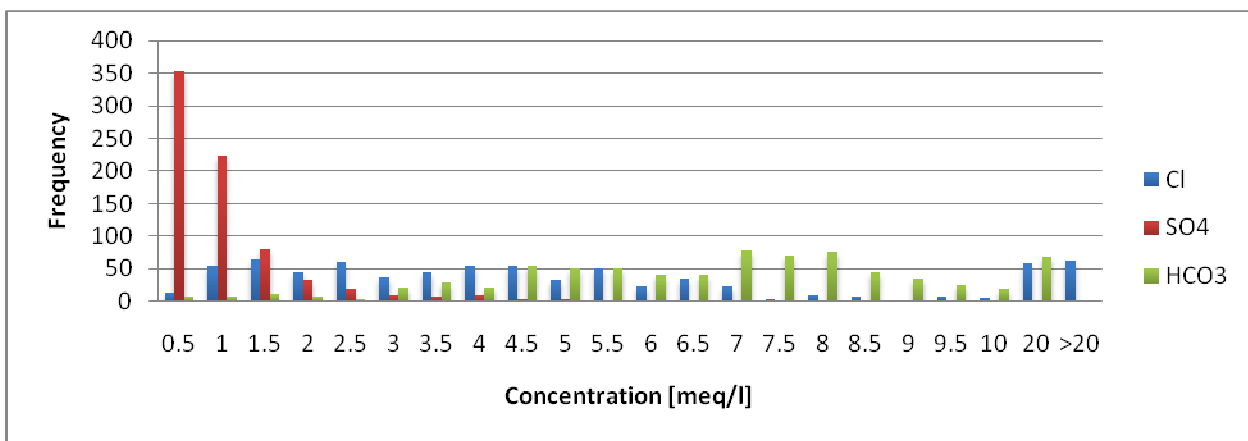


Figure 20: Frequency distribution of major anions for WMA1

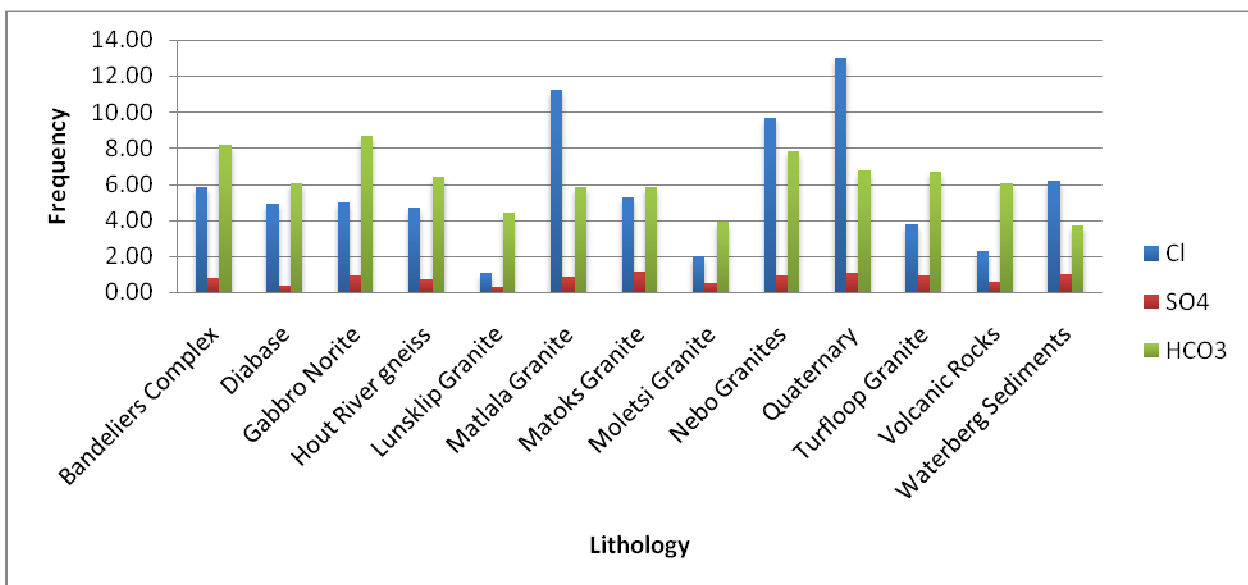


Figure 21: Average major anion concentrations versus lithology for WMA1

The frequency distributions of the major anion concentrations (Figure 20 and Figure 21) show a diverse picture, with a positively skewed sulphate (SO_4) distribution and a negatively skewed bicarbonate (HCO_3) distribution. The chloride distribution appears inconclusive. Essentially SO_4 dominates the lower anion concentrations and HCO_3 the higher anion concentrations. SO_4 sources are mostly related to anthropogenic processes. Bicarbonate dominating the higher anion concentrations correlates with lower mineralized water. A plot of average anion concentrations for the different geological units in WMA1 shows elevated chloride (Cl) concentrations in the Matlala and Nebo granites as well as quaternary deposits, while bicarbonate (HCO_3) dominate in the remainder of the geological units.

Houtriver Gneiss

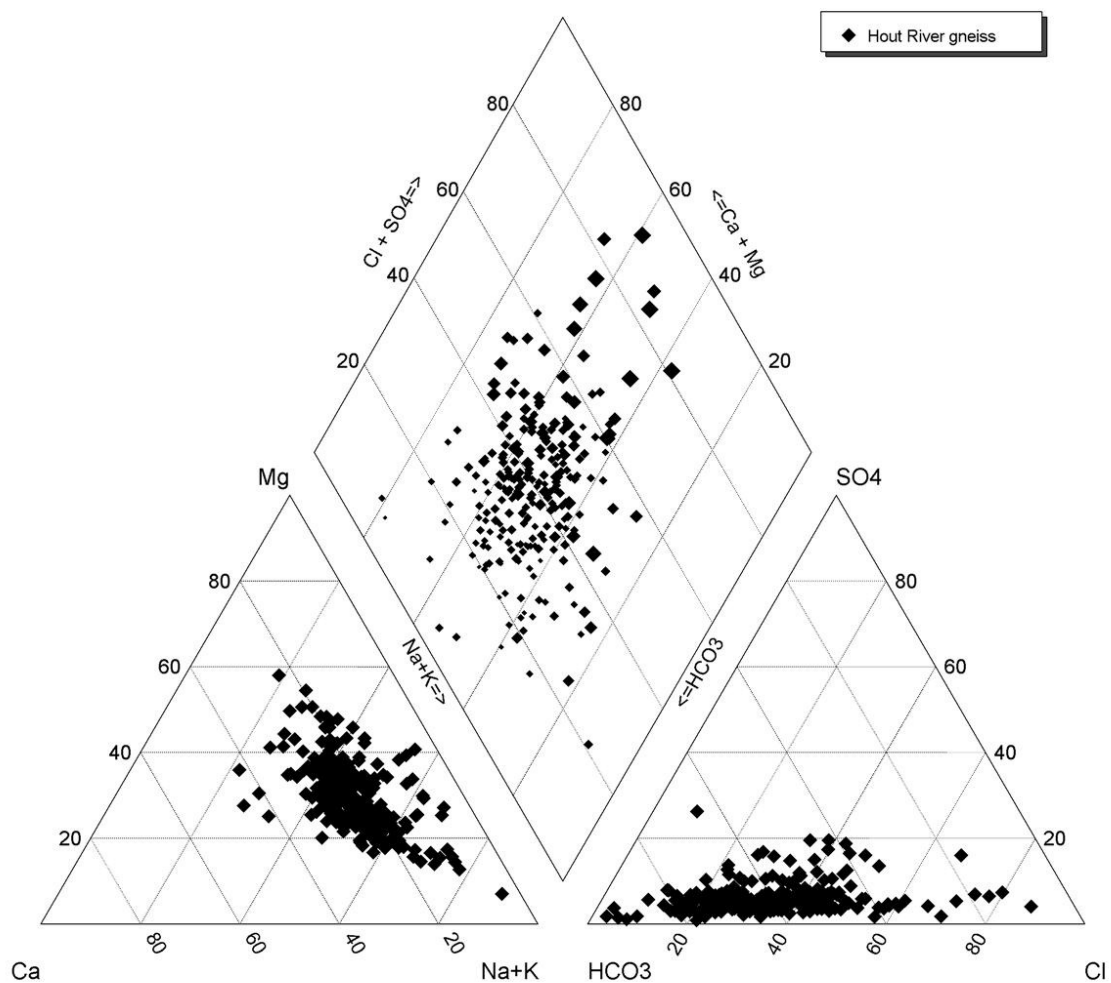


Figure 22: Piper plot for the Houtriver gneiss in WMA1

The Piper plot (Figure 22) illustrates the geochemical characteristics of the Houtriver gneiss suite, shows the groundwater compositions trending between two cation end members i.e. 60% Na+K, 20% Mg, 20% Ca and 40% Na+K, 40% Mg, 20% Ca. The anion concentrations show a typical

groundwater evolution between bicarbonate and chloride and trend between 80% bicarbonate and 60% chloride with less than 20% sulphate. The Piper plot reflects the dominance of a Na-Mg-HCO₃ water type. The bicarbonate concentrations generally decrease with increasing salinity while chloride increases with increasing salinity. As the main bicarbonate sources are from rainwater, decomposing organic material and atmospheric CO₂ it rather reflects fresh or recently precipitated groundwaters. Therefore, the dominant groundwater type in the Houtriver gneiss suite represents freshly recharged groundwater with some degree of evolution as magnesium and calcite are exchanged (cation exchange reactions) with sodium to form a Na-Mg-HCO₃ water type. The enriched chloride concentrations are derived from groundwater evolution as salinity increases. Therefore, groundwater evolution does occur, forming Na-Cl rich water. Following the mass balance modelling method, increasing sodium with reducing magnesium and calcium with increasing chloride and decreasing bicarbonate indicates halite solution as a sodium source. Evapotranspiration and solution of salts in the system also contributes to a solution.

The hierarchal cluster analysis (Appendix C) distinguishes between two major clusters. The only noticeable distinguishing factor controlling the two different clusters are the difference in total dissolved salts (TDS)/salinity and chloride concentrations. Cluster one shows highly elevated TDS values and chloride concentrations compared to cluster two, therefore characterizing highly mineralized and evolved groundwater. Most of the samples associated with cluster one are located in the northern part of WMA1, correlating with the quaternary deposits and Bandeliers Complex intrusions found in that area. The high TDS and chloride concentrations can be related with the quaternary deposits as well as groundwater discharge area. A minority of the samples from cluster one located in the southern part of WMA1 are found either near alluvial aquifer systems or contact zones between different geological units such as the Matlala granites. However, cluster one can't be characterized only by these influencing factors as a large numbers of samples from cluster II fall in the same category.

Rock source deduction characterizes cluster one as carbonate weathering with cation exchange reactions where halite, albite and reverse softening are sources for sodium, and carbonate weathering source for calcium. Cluster one is dominated with Mg-Na-HCO₃ water type with carbonate weathering and albite or ion exchange as major sources. These two clusters form end-members; cluster I dominated by a Na-Cl and cluster one dominated by a Na-Mg-HCO₃ water type.

Bandeliers Complex

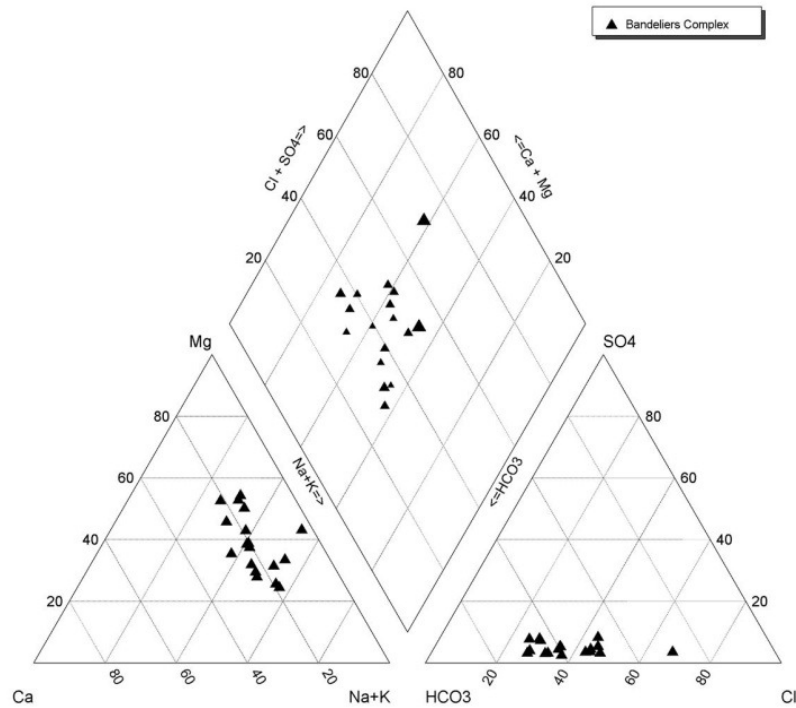


Figure 23: Piper plot for the Bandeliers Complex for WMA1

The Piper Plot (Figure 23) illustrating the geochemical characteristics of the Bandeliers Complex shows a dominant groundwater composition of Na-Mg-HCO₃ with a single Na-Cl groundwater sample. That groundwater sample shows an enriched sodium chloride water type with high salinity, indicating more mineralized groundwater compared to the other samples in the Bandeliers Complex. A likely explanation might be a shallow borehole, representing higher mineralized water with an evaporated signature or groundwater evolution. The Bandeliers Complex groundwater characteristics show carbonate weathering with calcite precipitation, albite and ion exchange as possible sources for the ions.

Turfloop granite

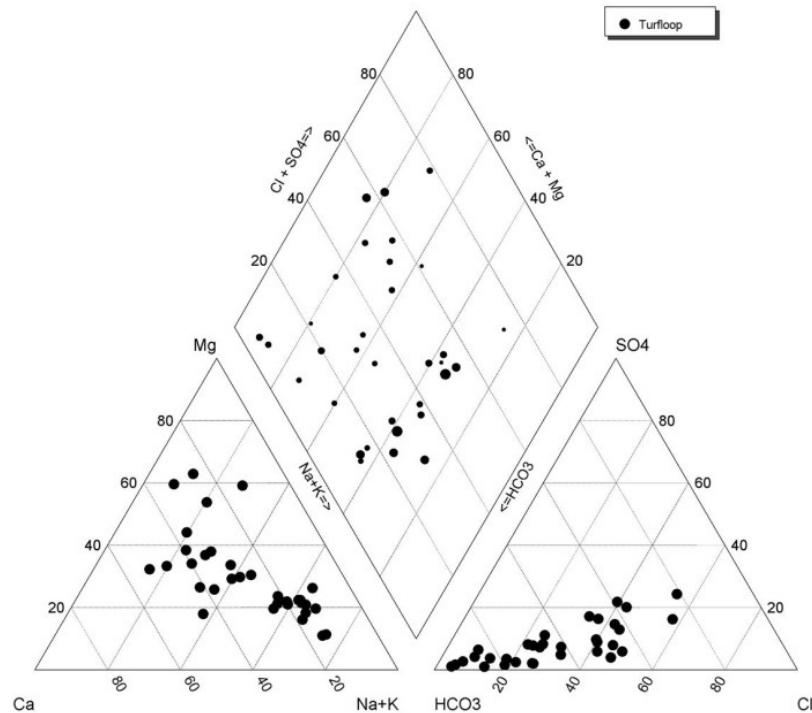


Figure 24: Piper plot for the Turfloop granites for WMA1

The Piper plot (Figure 24) illustrating the groundwater characteristics of the Turfloop granites shows a Mg-Na-HCO₃ groundwater composition. One of the groundwater samples showed a sodium chloride (Na-Cl) enriched water type with a very low total dissolved solid (TDS) concentration (335 mg/l). This could be due to low mineralized rainfall water or groundwater evolution along flow paths. Fresh rock weathering with enriched sodium and chloride minerals located within the Turfloop granites or other intruded igneous or metamorphic rock may give rise to the enriched Na-Cl water type. Dissolved carbonate playing the major role in a possible source for the bicarbonate rich water type as the Turfloop granites are located on a topographical high (Tzaneen escarpment) forming a recharge zone.

Waterberg sedimentary deposit

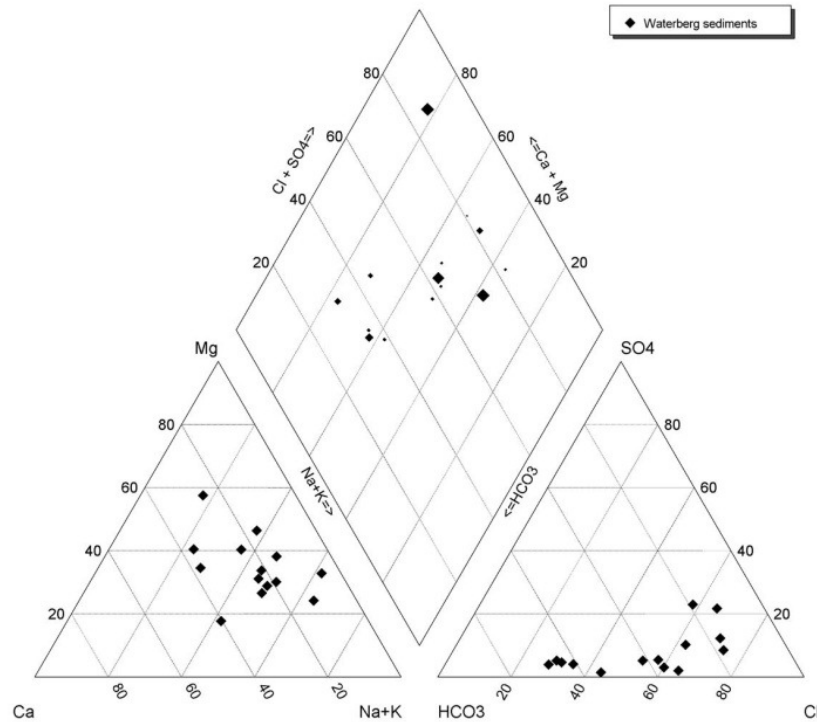


Figure 25: Piper plot for the Waterberg sediments for WMA1

The Piper plot (Figure 25) illustrating the groundwater characteristics for the Waterberg sediments shows a dominant Na-Mg-Cl-HCO₃ water type with lower TDS values and one sample with an enriched magnesium and chloride trend. The latter groundwater sample shows a magnesium chloride rich water type with very high TDS values (2148 mg/l) as well as elevated NO₃ levels (219 mg/l as NO₃). Elevated Nitrate (NO₃) concentrations can be related to anthropogenic origins. The groundwater characterization derived from the ion ratios show carbonate weathering with cation exchange, reverse softening and albite as possible sources for the ions. This again implies groundwater evolution from a bicarbonate dominant groundwater sample to a chloride dominant groundwater sample with cation exchange reactions.

Archaean Granitic Intrusion

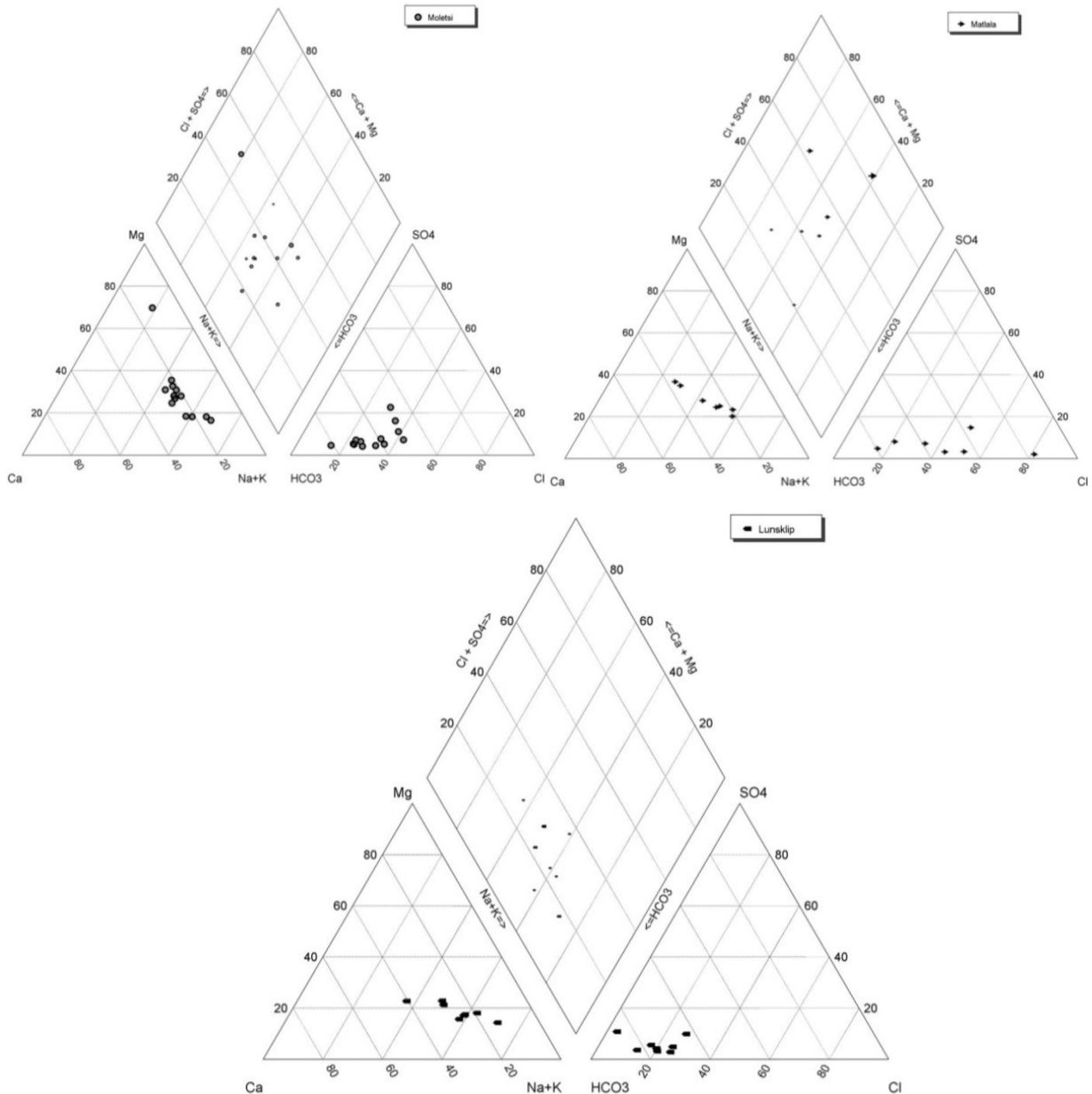


Figure 26: Piper plots for granitic intrusions for WMA1

The Piper plot, Figure 26, represents the granitic intrusions (Moletsai, Matlala and Mashasane/Lunsklip) located in WMA 1. These three granitic intrusions located in the southern part of WMA1, form part of the groundwater recharge area. Except for the Matlala intrusive granites showing some degree of chloride enriched groundwaters the dominant groundwater composition is Na-HCO₃. All the groundwater samples has low TDS values indicating that the groundwater is less mineralized than the groundwater samples located to the north of WMA1. One of the samples located in the Matlala intrusive granites showed higher concentration of magnesium and sulphate relative to the other samples. This groundwater sample is located within a settlement

giving a possible explanation for the enriched SO_4 ion concentration as anthropogenic origin as no known sulphate source originated from granitic rocks. According to the ion ratios carbonate weathering and plagioclase weathering with albite and ion exchange are possible sources.

Nebo (Lebowa) granite

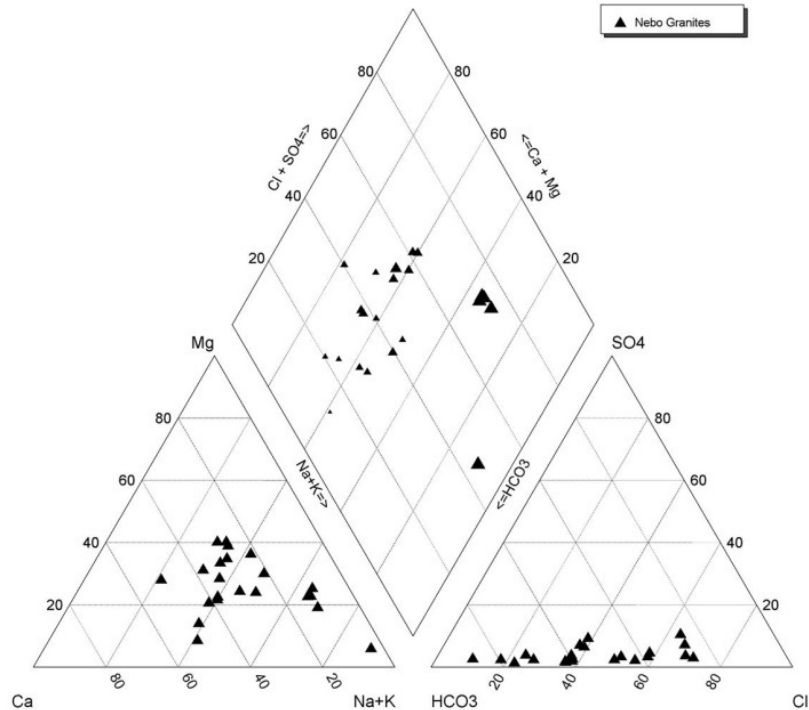


Figure 27: Piper plots for Nebo (Lebowa) granites for WMA1

The Piper plot (Figure 27) illustrating the groundwater characteristics of the Nebo (Lebowa) granites shows two dominant groundwater types, i.e. Na-Mg- HCO_3 water type and Na-Cl water type. The Na-Cl water type samples are all located in the northern part of the Nebo (Lebowa) granite intrusion or close to the Matlalanane River, contributing enriched chloride concentrations and elevated TDS values. Na-Mg- HCO_3 groundwater samples are located south of the Na-Cl water dominant samples forming part of the recharge area, which explains the lower TDS values. Carbonate weathering, cation exchange, albite and halite as sodium source and calcite precipitation are derived from the ion ratio methodology as possible sources.

Gabbro norite

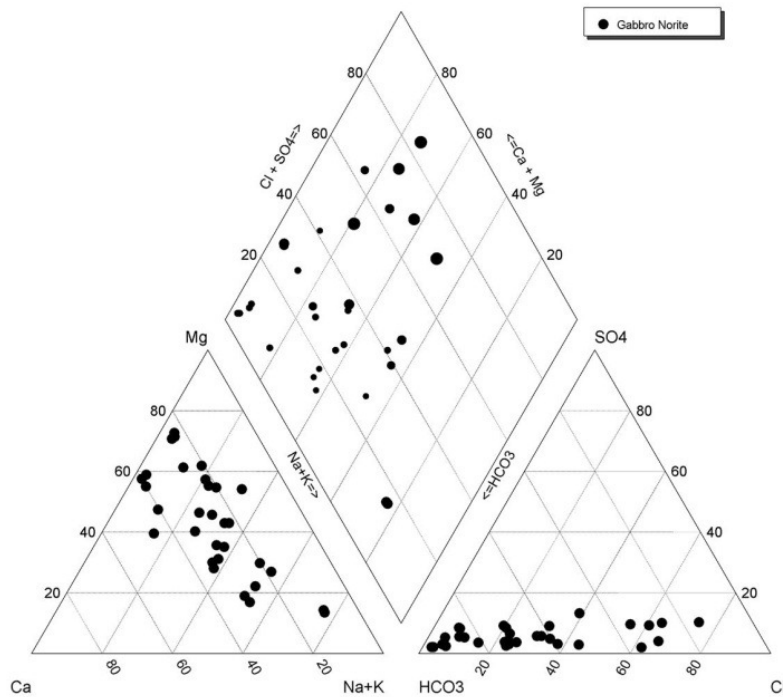


Figure 28: Piper plots for gabbro norite for WMA1

The Piper plot (Figure 28) illustrating the groundwater characteristics for the gabbro norite shows a Mg-Na-HCO₃ dominant groundwater composition. From the cat-and anions a clear groundwater evolution of the groundwater chemistry can be seen. Groundwater chemistry evolves from magnesium to a sodium and potassium rich cation and from bicarbonate to a chloride rich anion. The possible ion sources indicate carbonate weathering, cation exchange, albite, reverse softening and calcite precipitation.

Diabase

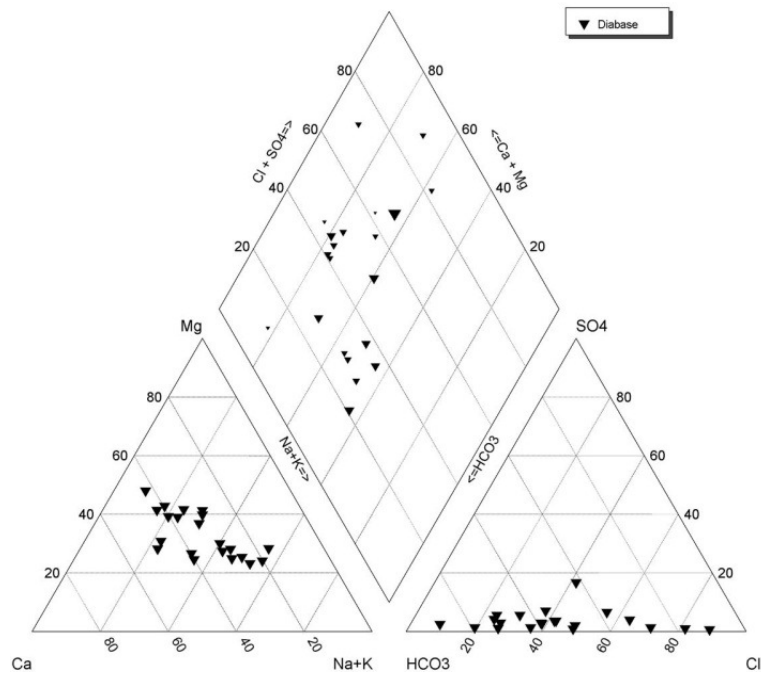


Figure 29: Piper plots for diabase for WMA1

The Piper plot (Figure 29) illustrating the groundwater characteristics of diabase within WMA 1 shows diverse groundwater types ranging from a Mg-HCO₃, Na-Cl to a Mg-SO₄. The anions show a typical groundwater evolution from a bicarbonate to a chloride rich anion water type. The cations are all clustered with almost equal percentages for all cations. From the ion ratios it is evident that cation exchange occurs, giving a possible explanation for the cations with almost the same concentration percentages.

Volcanic rock

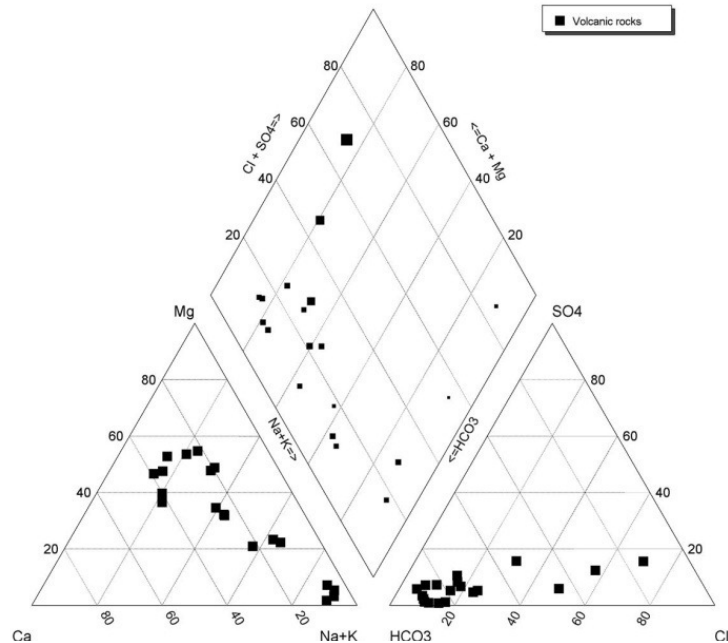


Figure 30: Piper plots for volcanic rocks for WMA1

The Piper plot (Figure 30) illustrating the groundwater characteristics of volcanic rocks shows Na-Mg-HCO₃ dominant groundwater composition and one groundwater sample with an elevated TDS value and a very high nitrate concentration (1786 mg/l) compared to the rest of the samples. From the ion ratios cation exchange and albite are possible sources. The sample with the elevated TDS and NO₃ shows reverse softening as a source for sodium. Reverse softening implies that the sodium-chloride ratio favours the amount of chloride, indicating that sodium is replaced in the system (cation exchange reactions) or chloride is added

6.1.2 WMA2

The mean concentration of silicate in the groundwater for the Goudplaats gneiss, Palmietfontein and Schiel samples are higher than the mean concentration for the Soutpansberg lava, Bandeleirs Complex, Biotite granite, Giyani Greenstone Belt and Diabase. There is no correlation between the rock types representing the different geological units and the silicate concentrations.

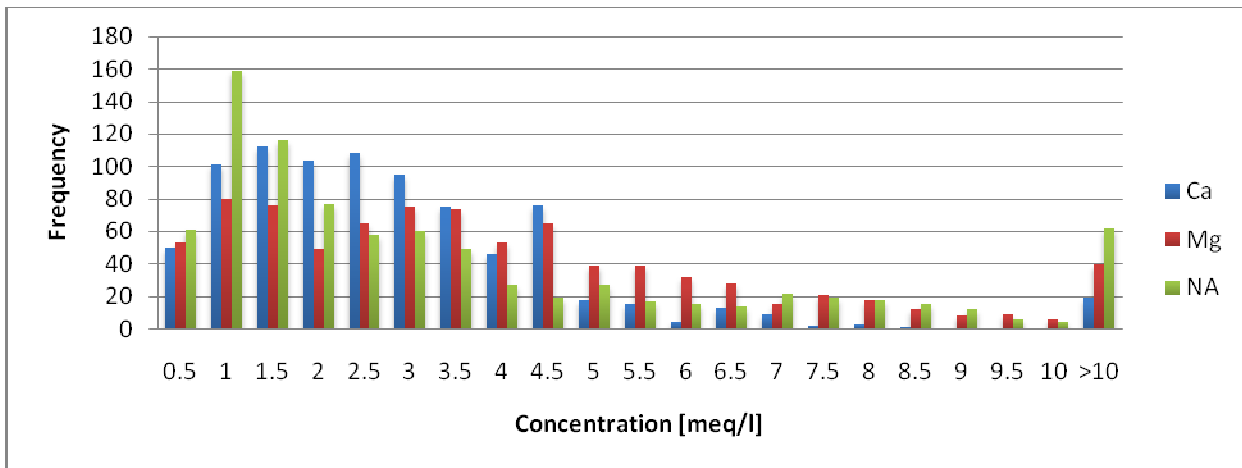


Figure 31: Frequency chart for major cations for WMA2

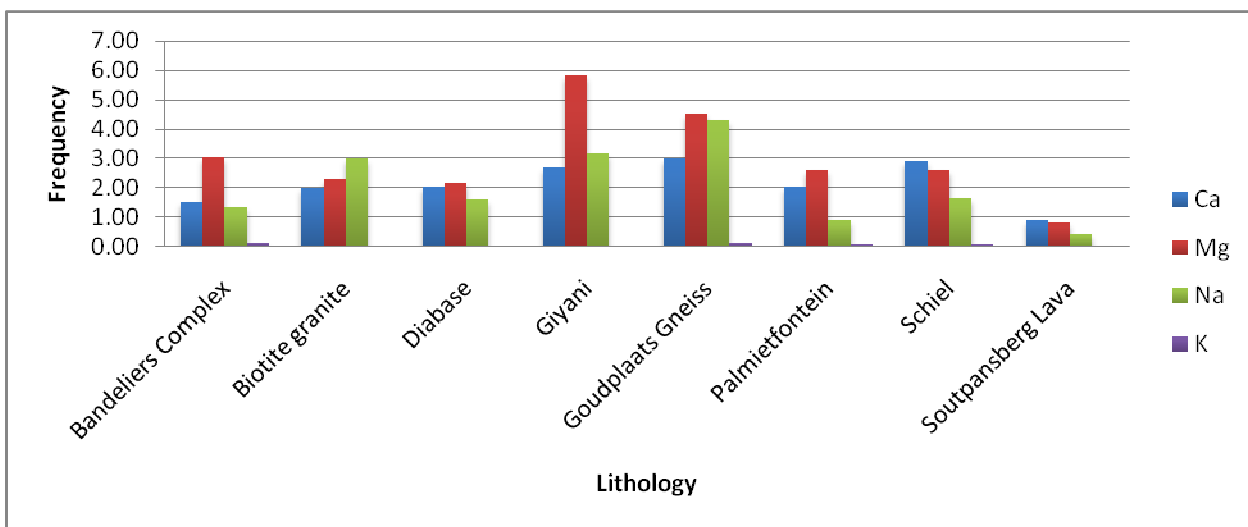


Figure 32: Average major cation concentrations versus lithology for WMA2

Sodium (Na) and Magnesium (Mg) are the two most dominant cations dissolved in the groundwater for WMA2 as seen in Figure 31. The frequency bar chart shows positively skewed cation distributions towards lower concentrations. Na and Ca dominate the lower cation concentrations and Mg the higher cation concentrations. This can again be attributed to cation exchange reactions, removing Ca from the system and adding Mg to the system. The highest measured cation concentrations are 1572 mg/l for Na, 482 mg/l for Mg and 434 mg/l for Ca. The frequency bar charts (Figure 32) of major cations for the different geological units in WMA2 show elevated cation concentrations for the Goudplaats gneiss and Giyani Greenstone Belt and very low concentrations for the Soutpanberg lavas. Both the Goudplaats gneiss and Giyani Greenstone Belts are mineralogically more complex than the Soutpanberg lavas, which derive a more diverse cation composition for the gneisses and greenstones. Magnesium dominates the cation concentrations in Goudplaats gneiss suite, Palmietfontein, Bandeliers Complex and Giyani

Greenstone Belt. Again a balanced cation concentration trend can be seen for diabase, which can be associated with the mineralogical composition and not to such an extent to recharge-discharge.

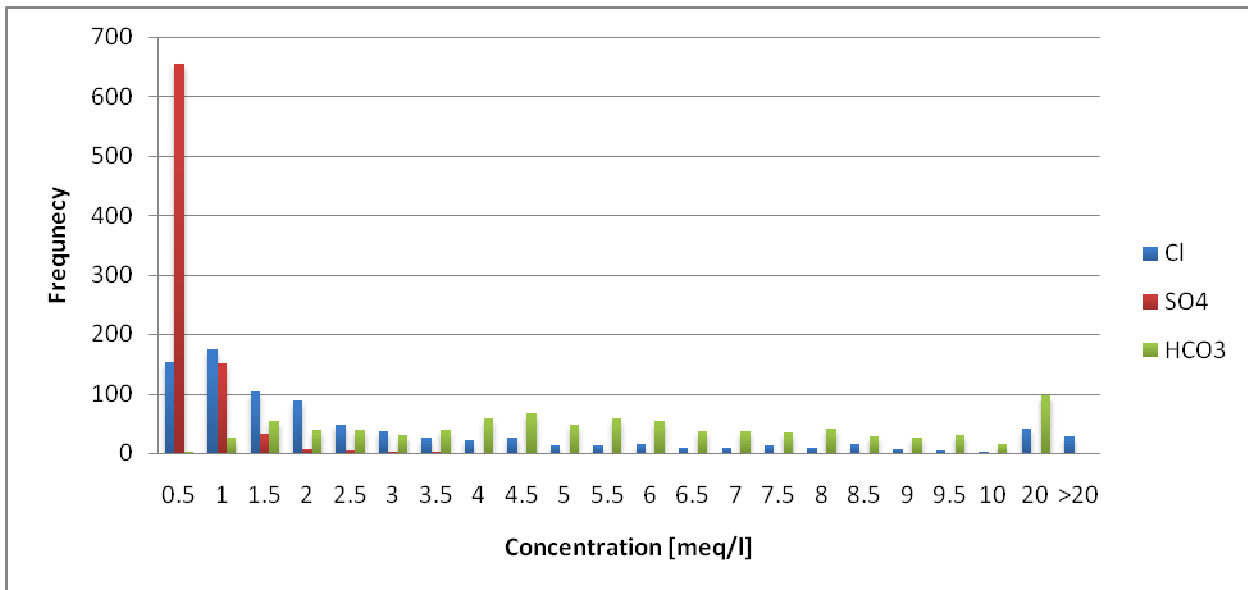


Figure 33: Frequency bar chart for major anions for WMA2

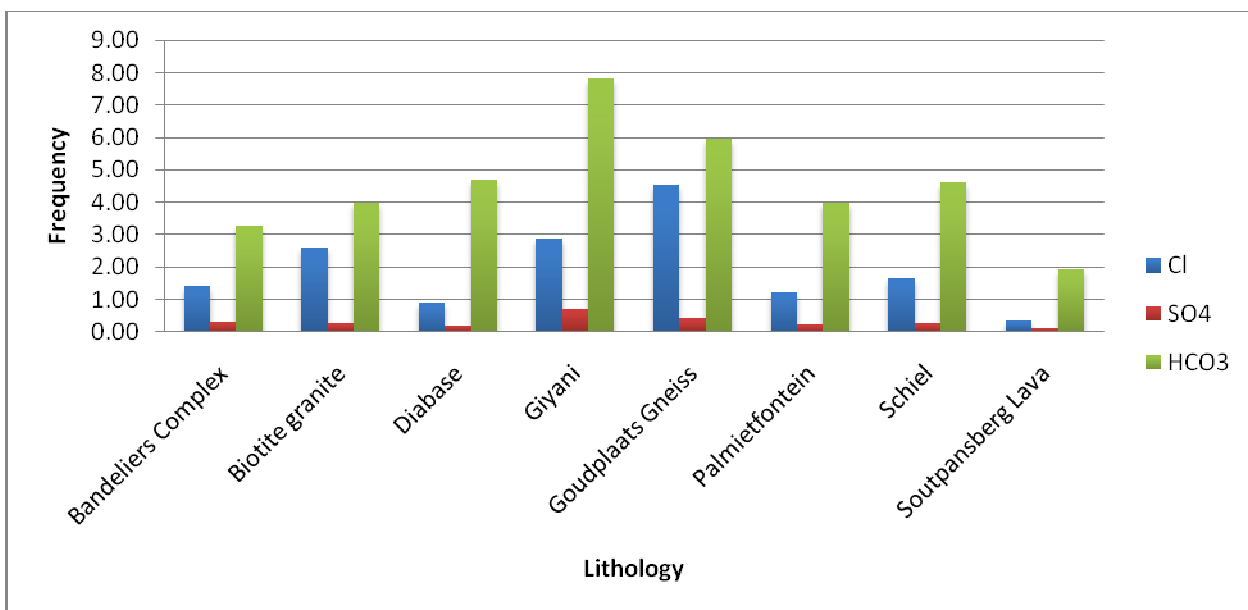


Figure 34: Average major anion concentrations versus lithology for WMA2

The frequency distributions, shown in Figure 33 and Figure 34, of the major anion concentrations show a positively skewed sulphate (SO_4) and chloride (Cl) distribution. The HCO_3 distribution appears inconclusive. Essentially SO_4 dominate the lower anion concentrations and HCO_3 the higher anion concentrations. It would be expected that chloride should dominate the lower anion concentrations. In most cases boreholes are drilled in or close to communities for groundwater

supply. These boreholes that show dominant SO_4 anion water type show an anthropogenic origin for SO_4 . Due to the higher recharge in WMA 2 compared to WMA1 and the large number of boreholes located in villages the lower anion is dominated by SO_4 and not Cl . The bicarbonate anion dominates in all geological units found in WMA2, with elevated (average) bicarbonate concentrations found in the Giyani Greenstone Belt. High chloride anion concentrations are found in the Goudplaats gneiss and biotite granite (Leucogranite). Both rock units have a mica rich mineralogy, which the source for chloride is from a weathered or non-weathered product.

Goudplaats gneiss

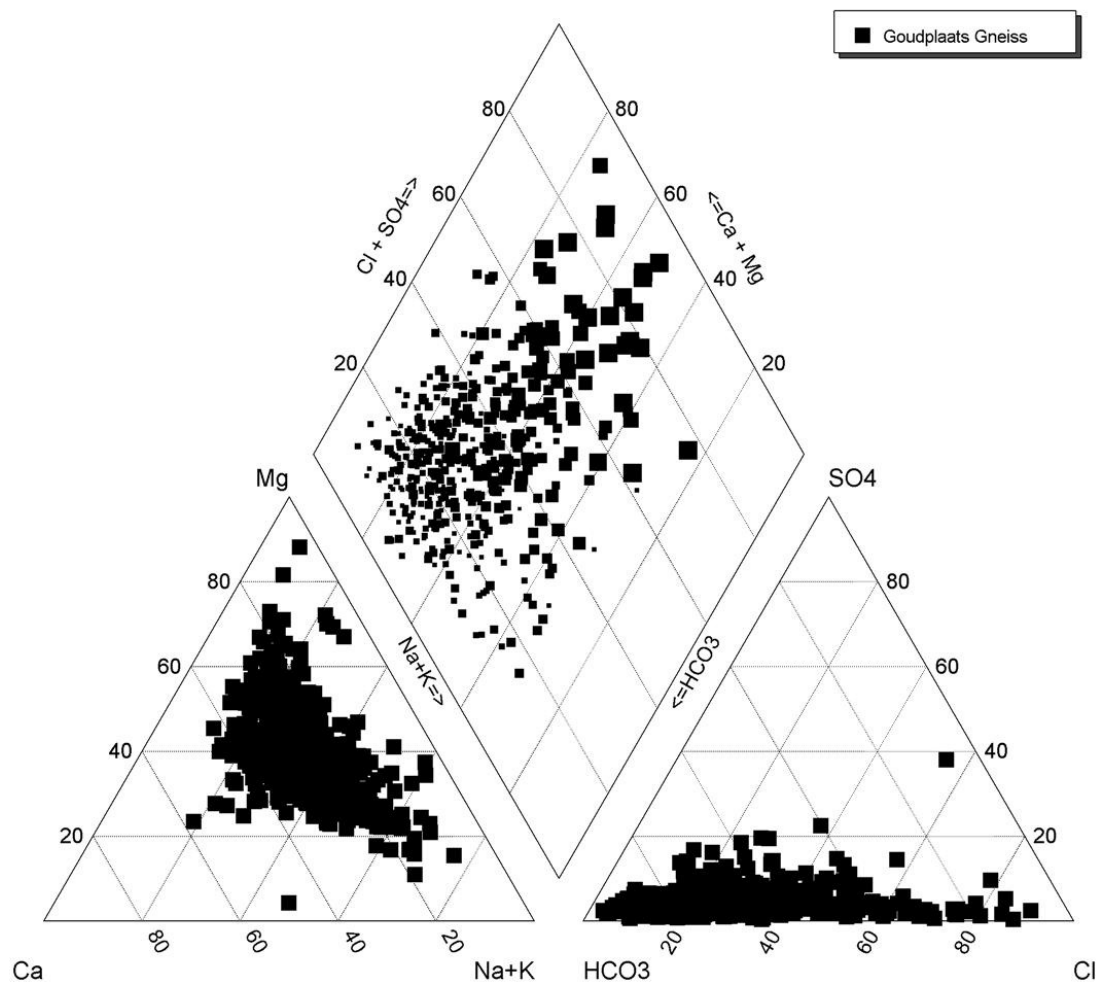


Figure 35: Piper plots for Goudplaats gneiss for WMA2

The Piper plot (Figure 35) illustrating the geochemical characteristics of the Goudplaats gneiss suite shows the groundwater composition trending between two anion end-members, i.e. between 30-100% HCO_3 with less than 20% SO_4 and between 55-95% Cl with 40% SO_4 . This shows a typical groundwater evolution between the bicarbonate and chloride. The piper plot reflects a

dominant Mg-Na-HCO₃ water type. The bicarbonate concentration decreases with increasing salinity and vice versa for chloride concentrations. The bicarbonate concentration signature is from atmospheric CO₂, implying that the groundwater is freshly recharged. The chloride anion end-member is derived either from groundwater evolution or from the mineralogical composition derived from the rock units.

The cluster analysis (Appendix C) distinguishes between two major clusters, represented in the piper plot. The noticeable distinguishing factors between cluster one and cluster two are total dissolved salts (TDS) and anion composition. Cluster one is characterized by low TDS values with bicarbonate as the dominant anion, whereas cluster two shows high TDS values with chloride as the dominant anion. All groundwater samples from cluster two plot spatially close to rivers where recharge occurs from the Tzaneen escarpment. Carbonate weathering is the major factor with plagioclase weathering unlikely.

Giyani Greenstone Belt

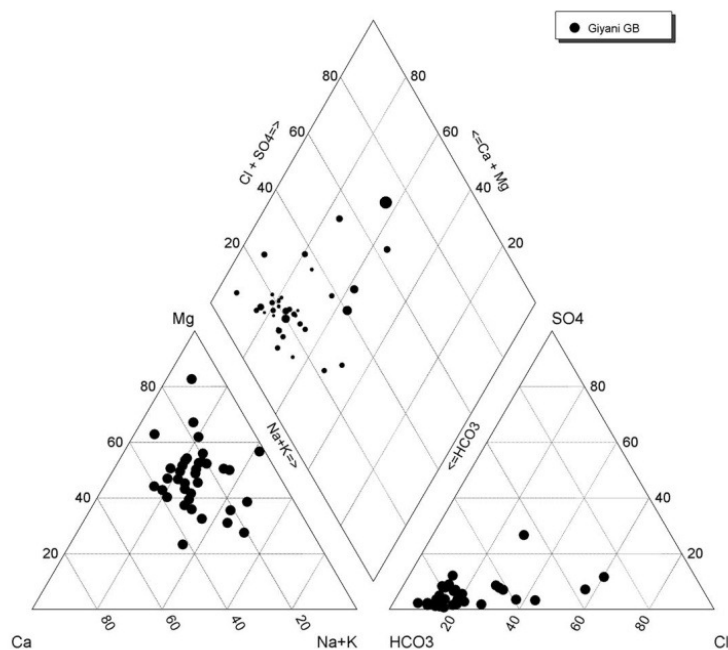


Figure 36: Piper plots Giyani greenstone belt for WMA2

The Piper plot (Figure 36) illustrating the geochemical characteristics of the Giyani Greenstone Belt shows Mg-HCO₃ dominant groundwater composition and two groundwater samples showing an elevated total dissolved solid concentration and an elevated sulphate concentration. With low total dissolved solids, bicarbonate as major anion and enriched magnesium cation concentrations, freshly recharged or young groundwater characterizes the area. Possible sources for the anions are granitic weathering and cation exchange reactions occurring.

Schiel Complex

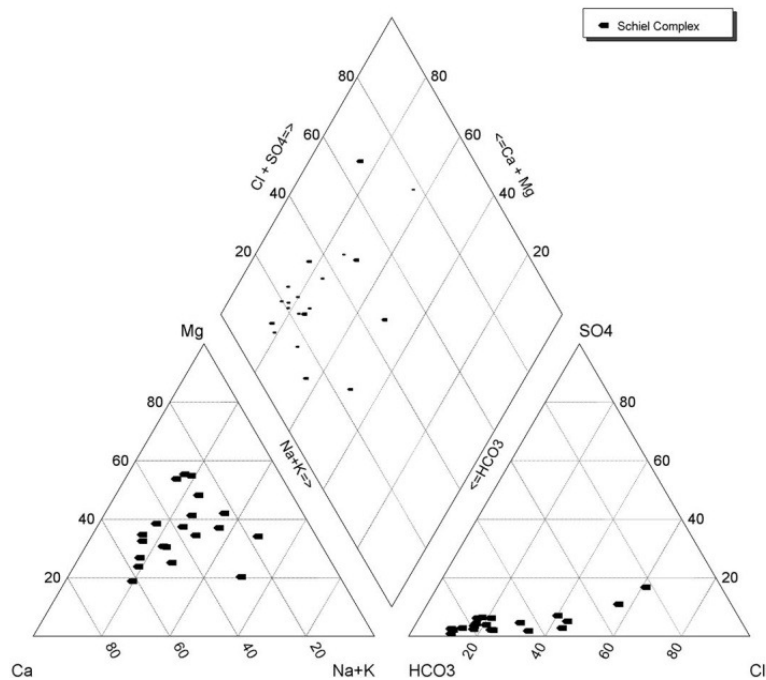


Figure 37: Piper plots for schiel Complex for WMA2

The Piper plot (Figure 37) illustrating the groundwater characteristics of the Schiel Complex shows a groundwater composition of Mg-Na-HCO₃. Two Groundwater samples have elevated nitrate levels compared to the other groundwater samples. Both samples are located within densely populated communities, one next to a school and the other within a garden, indicating an anthropogenic origin for the nitrate. Almost all cations have almost equal magnesium and calcium indicating cation exchange reactions.

Diabase

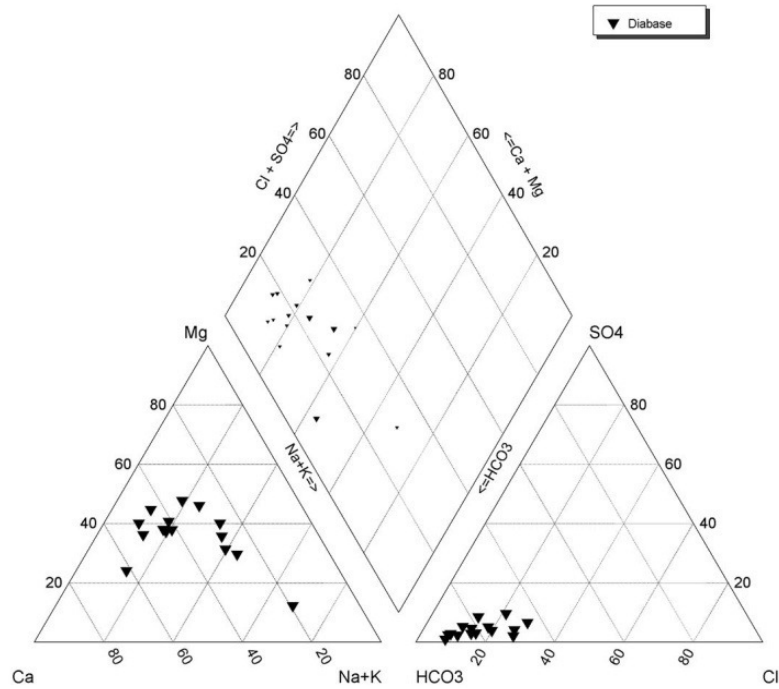


Figure 38: Piper plots for diabase for WMA2

The Piper plot (Figure 38) illustrating the groundwater characteristics of diabase rocks in WMA2 shows a Ca-Mg-Na-HCO₃ enriched water type. Low TDS values are associated with diabase. Bicarbonate originates either from decomposing organic material or/and from rainwater, indicating fresh groundwater. Unweathered diabase act as a groundwater flow boundary and act. This indicates that the groundwater signature isn't always representative of diabase since the groundwater doesn't originate from the diabase rocks. This and the mineralogically heterogeneous character of diabase gives the diverse groundwater composition.

Leucogranitic rock

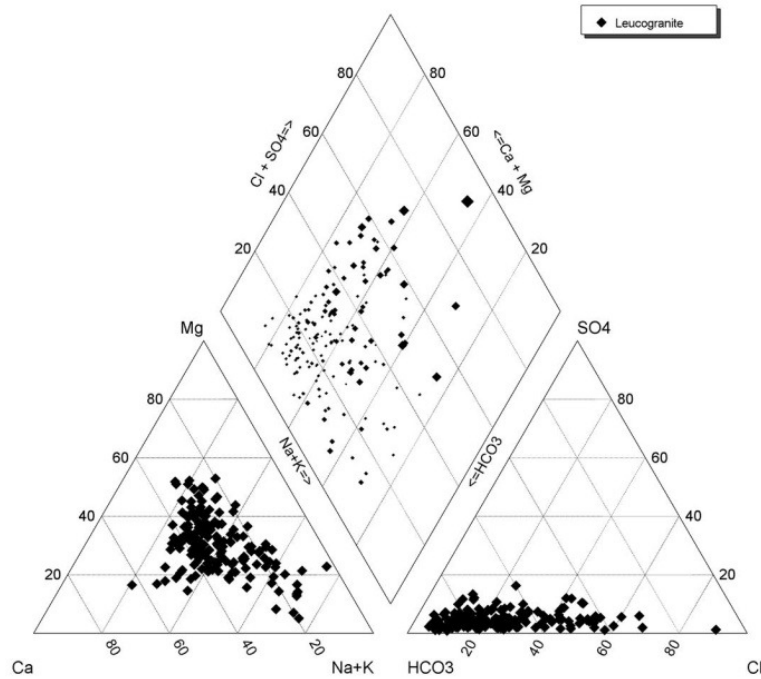


Figure 39: Piper plots Leucogranitic rocks for WMA2

The Piper plot (Figure 39) illustrating the groundwater characteristics of the Leucogranitic type rocks in WMA 2 shows a Na-Mg-Ca-HCO₃ dominant groundwater composition. Leucogranitic rock types (enriched in biotite) occur in the Tzaneen Escarpment, representing fresher groundwater and also a recharge zone. Bicarbonate originates from rainwater as well as decomposing organic material.

Bandeliers Complex

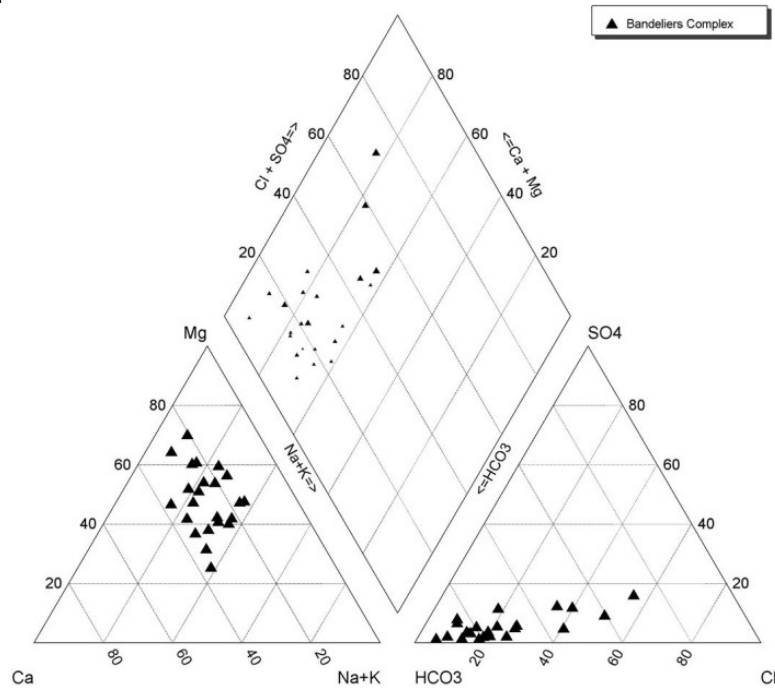


Figure 40: Piper plots for Bandeliers Complex for WMA2

As in WMA1 the Bandeleirs Complex illustrated by the Piper plot (Figure 40) is characterized by Mg-Ca-HCO₃ water facies. The Bandeliers Complex in WMA2 compared to the Bandeliers Complex in WMA1 has higher bicarbonate, magnesium and calcite concentrations with lower TDS values. This might be due to higher recharge and precipitation values. Some of the samples in WMA2 showed elevated TDS values, and correlate with a higher chloride concentration. Carbonate weathering with albite and ion exchange are suggested as possible sources for the ions

From the Piper Plots in WMA 1 and WMA 2 two distinguishing factors are identified. Cation exchange reactions play an important role in the cation signature and evolution trends of groundwater for both cations and anions.

6.2 DISCUSSION AND ASSESSMENT ON THE GROUNDWATER CHARACTERISTICS

6.2.1 Dominant groundwater type

The dominant water facies in WMA 1 are sodium-magnesium-bicarbonate and sodium-magnesium-chloride facies, with the first being characteristic of a more recently recharged groundwater, and the latter representative of an older groundwater with increased mineralization (TDS). Most of the samples in the Limpopo WMA (WMA1) show higher TDS (total dissolved solids)

values compared to the Letaba/Luvuvhu WMA (WMA 2) and a general pattern of elevated total dissolved solids with reduced precipitation/recharge values can be recognized for both WMAs. Samples taken in WMA 1 decrease in TDS in a south-easterly direction, while samples taken in the WMA2 decrease in TDS in a westerly direction. However, the Hout River Gneiss in WMA 1 is more prone to weathering than the other rocks in the WMAs and contributes to higher TDS values.

Sodium-bicarbonate and magnesium-bicarbonate water types are generally found in the recharge areas (Blouberg, Soutpansberg) and the southern side of WMA1.

The quaternary deposits south of the Blouberg Formation are characterized by a sodium-chloride water type and very high TDS values. Magnesium-chloride water facies are mostly associated with alluvium along rivers, especially in the northern part close to the Blouberg and Soutpansberg Formation. Between the Petronella-and Hout River Shear zones, sodium-bicarbonate and magnesium-bicarbonate water types are found, which might indicate groundwater subjected to cation exchange reactions. The clearly dominant groundwater type in WMA2 is magnesium-bicarbonate facies, indicative of a fresher, recently recharged groundwater.

6.2.2 Origin of groundwater composition

Hounslow (1995) gave cation and anion ratios which were used in the analysis to determine the rock sources. The following rock source deductions for the different geological units or rock types were made based on Hounslow's (1995) description:

- The Bandelier Complex, consisting of amphibolites, mafic granulite, and metapelites shows a dominant carbonate type weathering without releasing silica (as derived from the bicarbonate-silica ratio, calcium-sulphate ratio and amount of TDS). This is an indication of a highly mineralized water in circulation within the geological units (assuming the system is not closed), indicating older groundwater. WMA2 shows to some extent silicate weathering (albite releasing silica) as well, which indicates that a fresher groundwater component (recharged groundwater) is found. From the calcium and magnesium ratio calcite precipitation (removal of Ca from solution) is associated with the Bandeliers complex together with cation exchange.
- The Waterberg sediments located to the north-east of WMA1 form a localized recharge area, showing carbonate and albite weathering. Sources for the ion ratios sodium source (other than halite) indicate either albite or ion exchange, contributing to albite weathering. However, albite (plagioclase) minerals only form in a small percentage in sedimentary rocks. Therefore, sodium sources could rather be derived from ion exchange or weathering of calcite cementation agents.

- The different granitic intrusions i.e. the Matok, Matlala, Moletsi and Lunsklip (Mashasane) granites, show weathering from both carbonate and silicate sources, with sodium sources other than halite and calcium sources other than gypsum (carbonate or silicate). These granite intrusions have a high amount of silicate within the rock mass therefore silicate should be the dominant weathering phase. However, depending on the depth of weathered aquifer, carbonate weathering is characterized by higher mineralized water compared to silicate weathering. Therefore, silicate weathering is characterized by higher recharge areas (low TDS) and freshly weathered granites while carbonate weathering is associated with higher TDS values.
- The Turfloop granite formation occurs in the south of WMA1 and WMA2, forming part of the localized recharge area in the Tzaneen escarpment. Carbonate weathering with cation exchange characterizes the Turfloop granites. All data show a highly mineralized groundwater type which is contradictory to the fact that the boreholes are located within a recharge area. This could be mineral composition affecting the ion ratios from the weathered mineral products or sampled boreholes that had prolonged groundwater residence times. Diabase intrusions occur throughout both WMA's and are chemically similar to gabbro, with plagioclase feldspar, clinopyroxene, olivine and enstatite or augite as major minerals. Carbonate weathering and albite weathering are the dominant weathering processes for the diabase intrusions in WMA1, with cation exchange reactions more prominent in WMA2. Reverse softening as well as albite and ion exchange contribute to sodium sources. Dolomite and limestone weathering contribute to the magnesium sources. These dolomite-limestone weathering sources are an indication of highly enriched calcium and magnesium sources such as calcrete, which is abundant in the north of WMA1.
- Nebo granites (Lebowa granites), located east of WMA1, are characterized by carbonate weathering and cation exchange. Sodium sources from albite or ion exchange reactions and reverse softening together with calcium sources from carbonate or silicates weathering indicate processes and sources characterizing the Nebo granites. Magnesium sources are from dolomite dissolution and calcite precipitation. The Nebo granites forming part of the Bushveld Complex might be an important rock weathering source for the groundwater in WMA1 as the groundwater flow occurs from these Nebo granites in the west flowing east into the study area in WMA1. No definite mixing relationship between this geological unit and the groundwater has been identified.
- Volcanic rocks located in the south western side of WMA1, forming part of the Tzaneen escarpment, show carbonate weathering with cation exchange reactions to be the dominant sources for the groundwater composition. Albite (Plagioclase) or ion exchange are sources

for the measured sodium in the groundwater, and calcite precipitation or dolomite (Ca-Mg-Carbonate enriched rock such as calcrete) dissolution is major sources for magnesium.

- Quaternary deposits show carbonate weathering and cation exchange reactions as dominant weathering processes with albite, ion exchange and reverse softening to be the source for sodium. Calcite precipitation or dolomite (calcrete type rocks) dissolution are the major sources of magnesium.
- The Hout River gneiss has the largest areal extent with most borehole data showing dominant carbonate weathering derived from bicarbonate-silicate ratio and TDS values. A total of 83% of all borehole data show cation exchange reactions to be the major influencing factor, with albite or ion exchange as the dominant sources for sodium. Calcite precipitation or dolomite (calcrete type rock) dissolution are the dominant influencing processes for magnesium as a sources.
- Biotite granite (Leucocratic Biotite Granite), south of WMA2 forming part of the Tzaneen escarpment (recharge area), shows an even percentage of silicate and carbonate weathering. Silicate weathering indicates albite weathering releasing considerable amounts of silica into solution. Cation exchange and albite weathering plays an important role for the major cation sources.
- The Giyani Greenstone Belt, located east of WMA2, shows a relatively flat topography and forms a discharge area. Almost all data derived from bicarbonate and silicate, TDS and calcium sulphate ratios indicate carbonate weathering (indication of high TDS values) with cation exchange reactions, implying that the groundwater is subjected to more mineralized waters. Calcium other than gypsum, carbonate or silicate, calcite precipitation and albite (plagioclase) are indicated as possible sources for calcium and magnesium.
- The Goudplaats gneiss Formation forms another important geological unit in basement rocks located throughout WMA2, which is characterized by carbonate weathering, cation exchange reactions influencing weathering processes and albite weathering, calcite precipitation and ion exchange.
- The Schiel Complex located in quaternary catchment A91C, consisting of syenite, shows similar weathering processes and cation sources to the Goudplaats gneiss and most other geological units i.e. carbonate weathering, cation and ion exchange reactions, calcite precipitation and some silicate weathering.

Gneisses consist generally of feldspar, quartz, mica (muscovite and biotite) and hornblende. While potassic feldspars (orthoclase) and muscovites are enriched in K, biotites are enriched in K and/or

Mg and hornblende in Ca, Mg or Fe. Due to the hardness (Bishop, et al. 2001) and according to Bowens reaction series, biotite and hornblende will weather before potassium-feldspar, indicating that during the early stages of weathering of gneiss the groundwater chemistry will be preferentially enriched in Mg (from biotite and hornblende) and only at a later stage enriched in K (potassium-feldspars). Hence a change in cation mineralization might be seen along a flowpath / age of the water due to cation exchange reactions. Shallow and younger water from higher rainfall and recharge areas should be enriched in Mg. Accordingly the samples from WMA 2 are more enriched in Mg and HCO_3 in comparison to samples from WMA 1, which are generally more enriched in Na, K and Cl. The latter related is to:

- (a) evaporative concentration of chloride due to low recharge and
- (b) increased dissolution of chloride bearing minerals along deeper flow paths.

Other rock forming minerals influencing the groundwater chemistry are the amphibolites, mafic granulites and metapelites of the Bandeliers Complex, which are enriched in Ca, Mg, K and Na. Intruded dolerite dykes, consisting of olivine (Mg and Fe rich minerals), pyroxene (Ca, Mg, Na and Fe rich minerals) and plagioclase (Na and/or Ca rich minerals) provide a source of mineralisation.

The groundwater samples don't show a defined correlation between the geology and groundwater characteristics. Almost all geological units have carbonate weathering, derived from anorthite (plagioclase), and some silicate weathering, derived from albite (plagioclase). Therefore plagioclase plays an important role in the groundwater characteristics from both end members (either Ca or Na rich). Cation exchange reactions with Mg and Ca as dominant cations, since most water facies are either Mg or Ca dominant, contribute to the groundwater compositions.

6.2.3 X-Ray Defraction (XRD) and X-Ray Fluorescence (XRF)

A good presentation of the minerals present in the samples is derived from both the XRD and XRF analyses. The mineral and mineral phases present in the collected rock samples are tabulated in Table 7 and Table 8.

Table 7: X-Ray defraction (XRD) results [%]

	Amphibole schists	Bandeliers Complex	Quartzite	Diabase	Houtriver gneiss	Moketsi granite	Pegmatite	TP30 granite biotite	TP30 granite	TP37 Greenstone	TP37 Greenstone
Enstatite	21.36			25.96							
Hornblende	49.5			0							26.5
Smectite	20.7							30.15		34	30.15
Talc	8.4			4.88						5	
Biotite		12.92									
Cordierite		3.14									
Diopside		3.93		14.79	2.37		3.55		0.91		
Microcline		6.91		13.4	6.91	11.66	22.85	12.75	10.21	6.4	
Plagioclase		39.39		21.25	47.54	41.14	38.78	30.3	52.02	29	16.87
Hematite			1.12								
Quartz		33.72	98.89	8.18	29.61	36.73	16.15	8.89	13.97	10.3	2.85
Chlorite				9.74				6.99			
Muscovite				1.8	12.44		18.7		13.71		
Kaolinite					1.13			6.64	9.1	6.2	9.13
Illite										9	
Biotite						10.47		4.28			

Amphibolite schist (Greenstone) samples collected in WMA2 consists mostly of enstatite and hornblende. After weathering (dissolution) of enstatite and hornblende, smectite and talc formed as weathering products (see Table 7). The Bandeliers Complex consists of plagioclase, quartz, biotite, microcline, diopside and cordierite. With the formation of kaolinite, weathering products of plagioclase (feldspar) and biotite, potassium and magnesium are released into solution. Plagioclase and biotite form a source for potassium (K^+) and magnesium (Mg^{2+}) in groundwater originating from the Bandeliers Complex. Diabase consists of enstatite, diopside, microcline, plagioclase, quartz and muscovite. Chlorite and talc are weathering products from enstatite, and kaolinite from plagioclase and muscovite releasing potassium. These weathering products form a possible source for the cations. The Houtriver gneiss sample consists of plagioclase, quartz, muscovite, microcline, diopside and kaolinite as weathered product. Weathering of plagioclase and muscovite into kaolinite release potassium into the solution.

The Moketsi granite sample consists of plagioclase, quartz, microcline and biotite. Plagioclase and biotite weather to form kaolinite, releasing potassium and magnesium into solution. The Pegmatite sample collected in WMA1 consists of microcline, quartz, muscovite and diopside. From the weathering product kaolinite, potassium is released into the system. Four samples collected at different depths were retrieved from two excavated test pits, TP30 and TP37. Sample TP30 had a biotite rich granite overlying granite. The overlying more weathered layer of biotite rich granite shows a more diverse XRD signature compared to the less weathered deeper granite, enriched in plagioclase and more depleted in other minerals. Sample TP30 consists of microcline, plagioclase, quartz, biotite, muscovite and diopside and smectite and kaolinite as weathering products. Plagioclase and both micas produce smectite and kaolinite, releasing potassium into solution. Sample TP37 (greenstone) consists of hornblende, plagioclase, quartz and smectite, kaolinite and illite as weathering products. The weathered products release potassium, sodium and magnesium into the system as one of the contributing factors to the cation signature.

Weathering of the minerals present in the different geological units also depends on the stage of weathering, e.g. from Bowen's reaction series early stage weathering of amphibole schist depicts that Ca-plagioclase will weather before biotite. Therefore, after dissolution and formation of a weathered product sodium (from plagioclase) will be released into solution before potassium and magnesium (from biotite).

Table 8: Mineral phases present in the different geological units from the XRF analysis

%	Amphibole schists	Bandeliers Complex	Quartzite	Diabase	Hourriver gneiss	Moketsi granite	Pegmatite	TP30 granite biotite	TP30 granite	TP37 Greenstone	TP37 Greenstone
SiO ₂	49.50	67.79	98.17	51.17	73.39	72.39	72.48	57.06	63.61	55.33	55.41
TiO ₂	0.29	1.01	0.04	0.61	0.19	0.54	0.03	0.67	0.19	0.85	0.90
Al ₂ O ₃	6.55	13.31	0.27	11.83	13.86	13.00	17.04	16.96	20.35	17.34	13.63
Fe ₂ O ₃	8.84	5.86	1.01	11.40	1.79	3.06	0.33	9.68	2.58	11.35	12.94
MnO	0.18	0.07	0.00	0.21	0.07	0.05	0.03	0.05	0.01	0.09	0.12
MgO	22.58	0.87	0.00	10.92	0.37	0.24	0.00	2.84	0.20	2.49	4.93
CaO	8.42	2.99	0.00	11.05	1.67	1.16	0.96	0.72	0.93	0.66	5.00
Na ₂ O	0.93	3.33	0.00	1.47	4.31	4.10	3.34	2.90	5.22	0.78	2.15
K ₂ O	0.18	3.56	0.07	0.61	3.29	4.46	5.14	2.49	2.93	2.14	1.11
P ₂ O ₅	0.08	0.27	0.00	0.03	0.00	0.16	0.00	0.01	0.00	0.01	0.00
Cr ₂ O ₃	0.05	0.00	0.00	0.06	0.01	0.02	0.00	0.09	0.02	0.10	0.07
NiO	0.08	0.00	0.02	0.06	0.02	0.00	0.02	0.03	0.00	0.04	0.02
V ₂ O ₅	0.03	0.01	0.00	0.04	0.00	0.00	0.00	0.02	0.00	0.02	0.03
ZrO ₂	0.00	0.09	0.02	0.00	0.00	0.06	0.00	0.02	0.02	0.02	0.01
LOI	2.15	0.43	0.25	0.52	0.84	0.53	0.45	5.11	3.58	7.53	3.67
TOTAL	99.88	99.58	99.85	99.99	99.82	99.77	99.82	98.66	99.65	98.74	99.98

Calculating the molar mass of the four major cations (Ca^{2+} , Mg^{2+} , Na^+ and K^+) from the mineral phases analyzed by XRF (Table 8), the following conclusion could be made: The XRF analysis shows high sodium (Na^+) concentrations and low magnesium (Mg^{2+}) concentrations within granitic rock types seen in the Moketsi granites, pegmatite, Houtriver gneiss, Bandeliers Complex and sample TP30 (moderately weathered biotite granite). High magnesium (Mg^{2+}) concentrations and low potassium (K^+) within metamorphic rock types seen in diabase, amphibole schist and sample TP37 (greenstone). From the ion ratios albite weathering into kaolinite releases sodium (Na^+) into solution. Albite (plagioclase) is a common mineral in granitic rocks seen in the XRD analysis, thus sodium (Na^+) present in granitic rock types as mentioned above shows strong ion ratio correlation with albite as the major source. Weathering of pyroxene and biotite kaolinite releases magnesium (Mg^{2+}) as well as calcium (Ca^{2+}) and potassium (K^+) into solution, as seen in the samples from the metamorphic rocks, and forms a potential source for magnesium.

6.2.4 Weathering ration (factor)

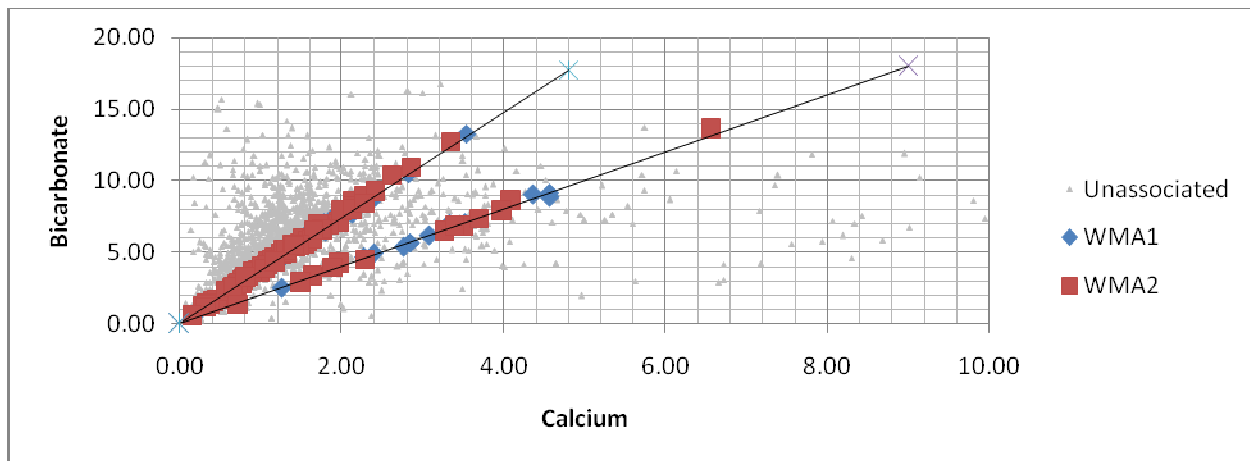


Figure 41: Weathering ratio (factors) for calcium vs. bicarbonate

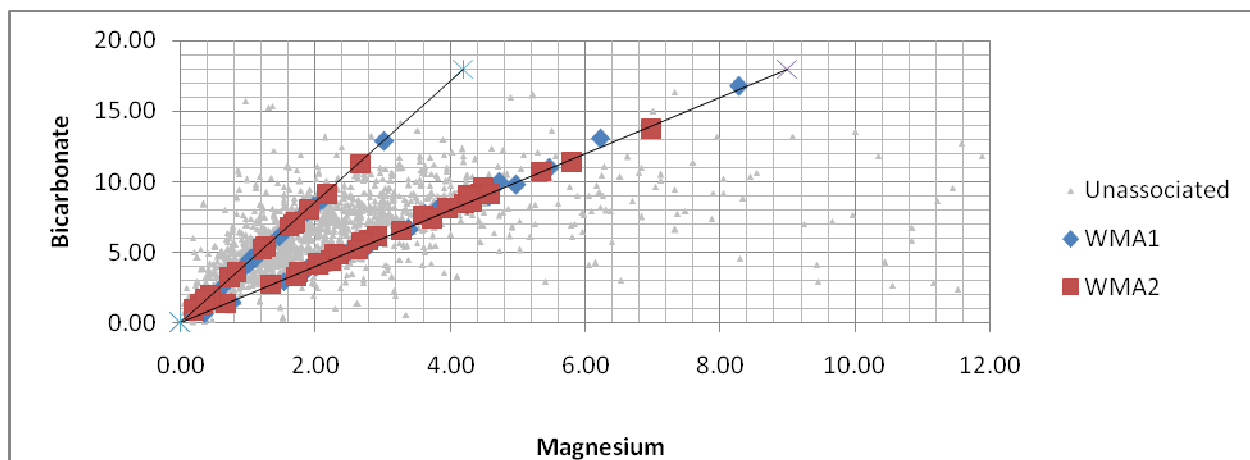


Figure 42: Weathering ratio (factors) for magnesium vs. bicarbonate

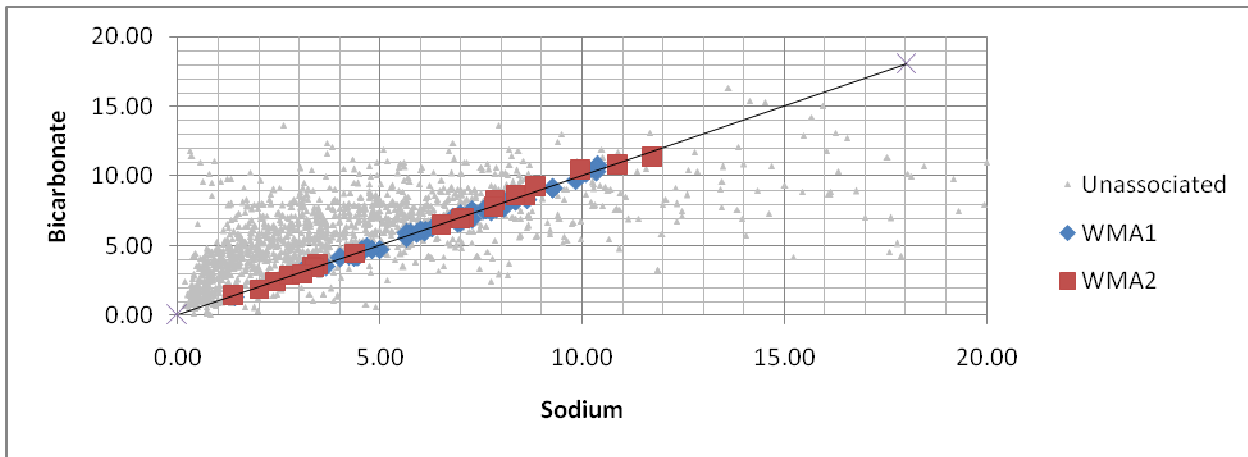


Figure 43: Weathering ratio (factor) for sodium vs. bicarbonate

According to Appelo and Postma (1994), groundwater samples with relative ion ratios indicated by weathering factors indicate a possible weathered product. Taking into account the mineral and weathered product a potential source can be derived as follows; granitic rocks with albite and anorthite weather into kaolinite, diabase and greenstone rocks with augite and pyroxene weather into kaolinite and gneissic rocks with biotite weather into kaolinite. However, from the 1486 groundwater samples for both WMA's only 12% of the samples could be associated with reaction ion ratios (as seen in Figure 41, Figure 42 and Figure 43). This shows the complexity of basement rocks, which is dependant on both weathering factor, ion ratios and evapotranspiration and cation exchange reactions. The associated groundwater samples correlating with the weathering factors are given in Table 9.

Table 9: Correlation results of the geological units for the different weathering ratios (factors)

	Ca:HCO ₃		Mg:HCO ₃		Na:HCO ₃
	1:2*	1:3.7*	1:2*	1:4.3*	1:3.7*
Population (samples)	n=73	n=38	n=86	n=24	n=80
Goudplaats Gneiss	56%	66%	57%	8%	16%
Houtriver Gneiss	29%	32%	X	8%	41%
Biotite granite	38%	18%	19%	46%	8%
Giyani Greenstone Belt	11%	8%	3%	X	X
Quaternary deposits	22%	13%	10%	29%	19%
Turloop granites	1%	11%	3%	X	3%
Inselburg granites**	X	X	X	X	6%

*Source: Appelo and Postma (1994)

**Inselburg granites consists of Matlala, Moletsi and Matoks granites

Taking into account the number of samples per geological unit, the percentages of correlated samples associate rather with the amount of samples per geological units than the weathering factors. However, a short discussion of the molar ratio results is given for the correlating samples.

Most groundwater samples (derived from Na/Cl ratio) show sodium other than halite i.e. albite (aluminosilicate mineral) and/or cation exchange reactions as possible sources. The aluminosilicate minerals such as albite have a good correlation (weathering factors) between albite and kaolinite as discussed in the weathering of primary minerals into secondary minerals (XRD and XRF) . Albite (sodium end member of plagioclase) weathers to kaolinite, releasing Na⁺ into the solution and giving a strong sodium rich groundwater composition. Another possible sodium source is through cation exchange reactions. Sodium can be exchanged after weathering with magnesium and calcium, removing magnesium and/or calcium, and adding sodium to the solution. Some samples do show halite as a possible source as well as reverse softening but to a much smaller extent. Dolomite (calcrete type rock) dissolution and/or calcite precipitation are the most prominent magnesium sources derived from Mg/Ca+Mg ratio. Augite (pyroxene) weathers to kaolinite mobilising magnesium as a major cation in the solution. Granite and dolomite (calcrete type rock) weathering are also possible sources for magnesium. Granitic weathering is only related to granitic rock types such as gneiss and granites. Dolomite (calcrete rock type) weathering might be an

indication of enriched calcium and magnesium rock sources such as evaporates and calcrete. Calcium sources are dominated by carbonate and silicate weathering processes and to a lesser extend by dissolution. Silicate minerals such as augite and anorthite weather to kaolinite, mobilising calcium. Calcium concentrations are influenced by cation exchange reactions either by adding or removing calcium from mobilized or bound magnesium.

The major influence of the anions is represented by highly refreshed or mineralized groundwater and mixing of both. These refreshed and mineralized groundwaters are dependent on the recharge-discharge zones. Other major influencing factors for the anions haven't been established, therefore further investigation for anion behaviour in basement rocks is essential to identify other influencing factors. From the XRD and XRF analysis kaolinite (weathering product) is present in both the samples (TP30 and TP37) collected at different depths. The contribution of cations to the groundwater chemistry can be derived from the weathering products, cation exchange reactions and evapotranspiration processes releasing certain cations into solution.

6.2.5 Geochemical evolution along flow paths

Prominent ridges and valleys with mountain ranges characterize the local relief of the study areas. Therefore, localized shallow circulating groundwater flow systems with slower deeper circulating groundwater flow systems may be characteristic of the groundwater flow systems. Relatively younger/refreshed groundwater types (-bicarbonates) are associated with localized shallow circulating groundwater flow systems occurring in higher lying areas such as the Blouberg, Soutpansberg and Tzaneen escarpment (recharge zones). The speculated slower and deeper circulating groundwater flow systems can also be associated with lower lying areas with lower rainfall and older/mineralized groundwater types (-chloride). However, these older/mineralized groundwater types are mostly associated with discharge zones.

In WMA 1 (Figure 44) a general downward gradient occurs from the south from Seshego northwards too the Blouberg Mountain and Soutpansberg Mountain Range forming a slow and deeper groundwater flow system. However, localized downward groundwater gradients occur towards the south originating from the Soutpansberg and Blouberg areas forming localized shallow circulating groundwater flow systems. WMA 2 (Figure 45) has a general downward gradient from the west to the east with the Soutpansberg Mountain range and Tzaneen escarpment forming downward gradients from the north and the south as localized shallow circulating groundwater flow systems.

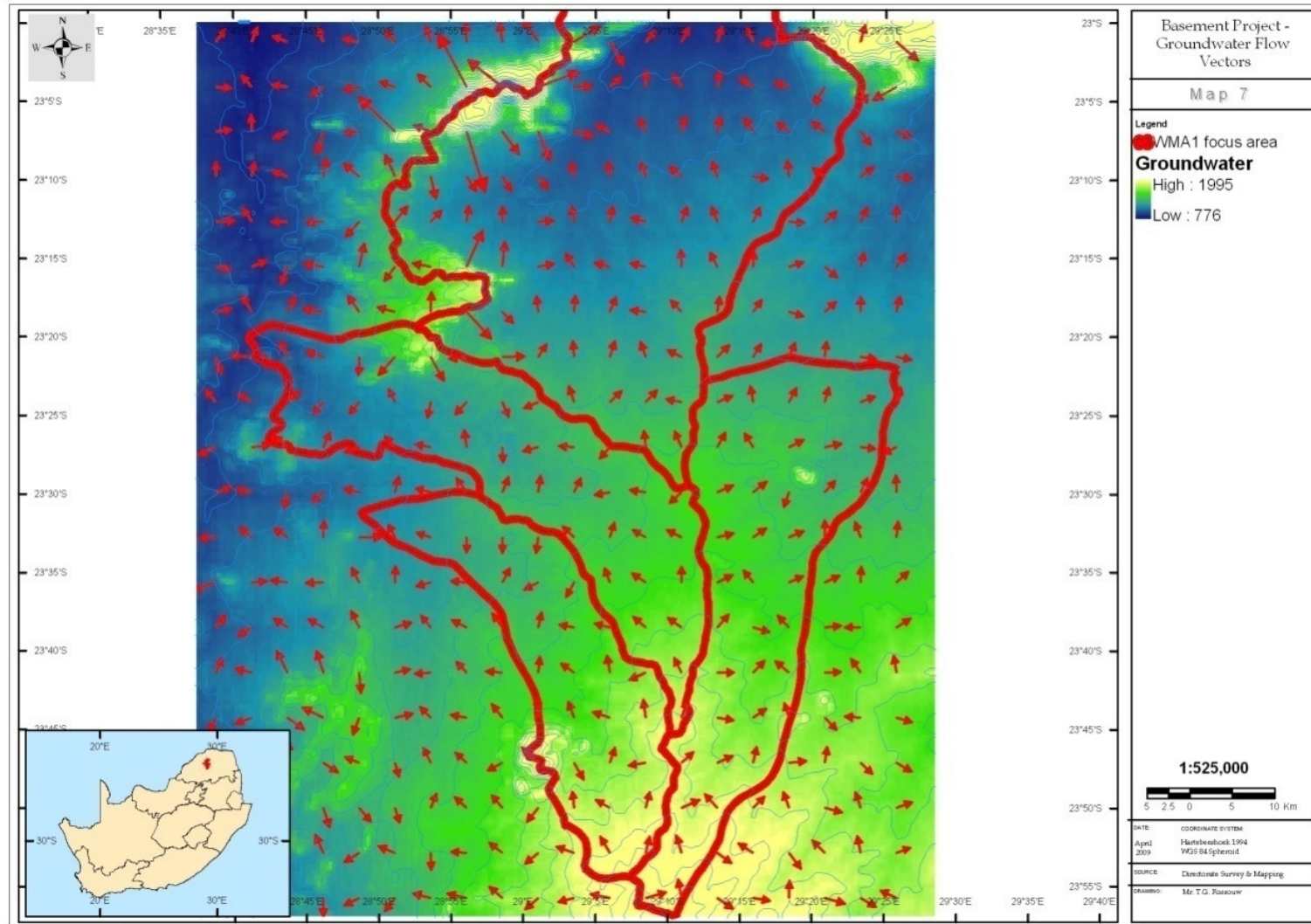


Figure 44: Groundwater vector flow direction for WMA1

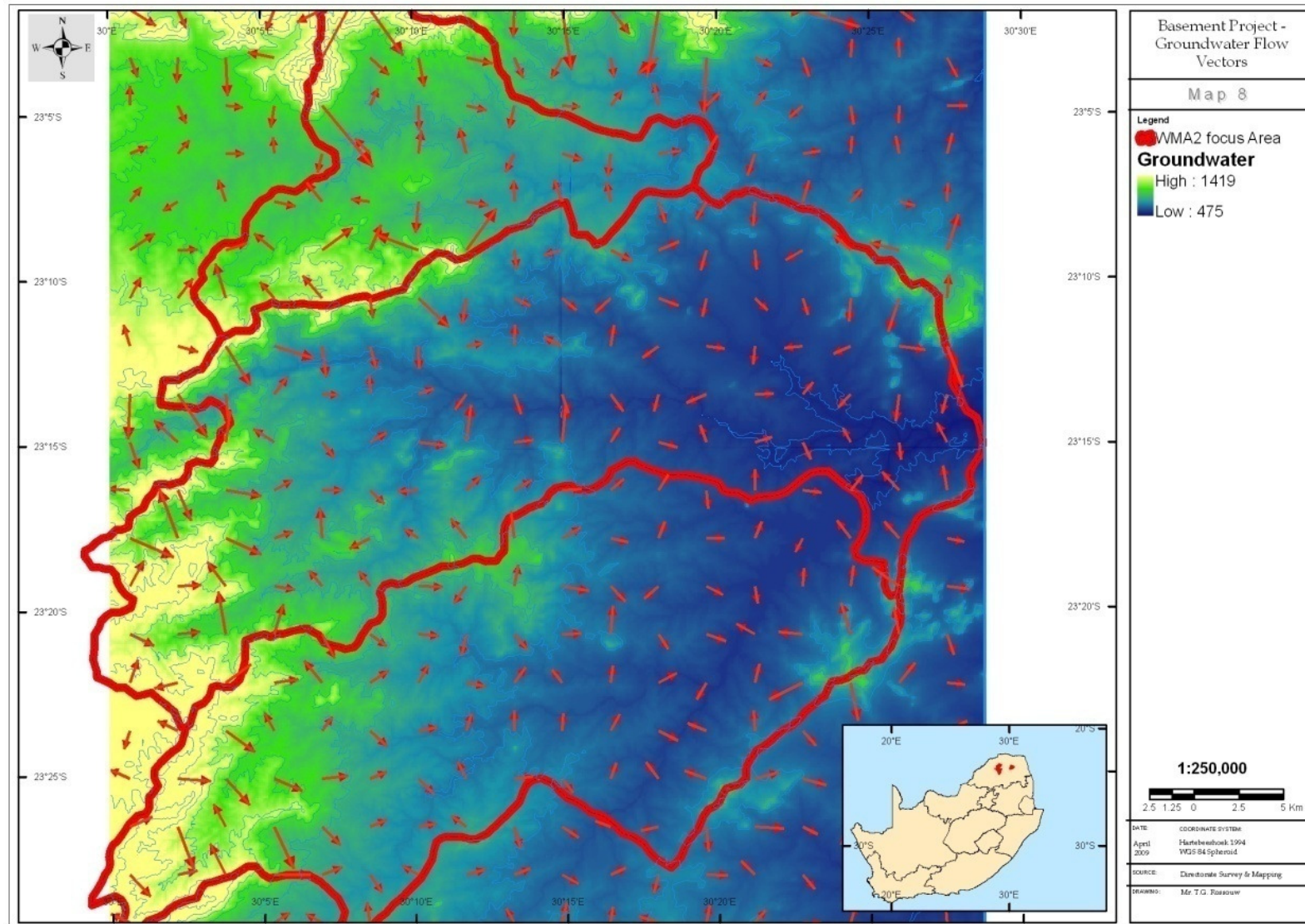


Figure 45: Groundwater vector flow direction for WMA2

In WMA1 the groundwater flow gradient (indicating possible groundwater chemical evolution) occurs along the Blouberg Mountain southwards towards the low lying areas. The groundwater composition measured in the Blouberg area shows a dominant magnesium-bicarbonate composition in the mountainous areas and a sodium-magnesium-chloride composition in the lower lying areas. Recharge occurs predominantly in the Blouberg Mountains with a bicarbonate rich groundwater composition while the lower lying areas have a chloride rich water composition as they are discharge regions. In WMA2 the groundwater gradient is mostly in an easterly direction and it is along this trend that groundwater becomes more enriched in chloride from a bicarbonate groundwater composition as groundwater undergoes mineralization. Sources for the major cations are albite, calcite reduction and/or cation exchange reactions.

6.2.6 Groundwater quality

Table 10: Average groundwater chemical concentration for the different geological units (colour coded)

Lithology	pH	EC	TDS	Ca	Mg	Na	K	Si	Cl	SO ₄	N	F	Alk.
WMA1													
Bandeliers Complex	8.3	155.0	1100.2	57.7	76.5	148.9	14.9	34.4	207.9	39.5	13.8	0.3	353.1
Diabase	7.9	120.2	847.4	81.7	46.8	99.4	2.3	29.0	174.2	17.2	12.7	0.6	302.7
Gabbro Norite	8.2	151.0	1145.6	89.4	86.7	110.5	3.6	31.7	176.7	45.2	23.0	0.5	426.2
Hout River gneiss	8.2	123.2	881.4	53.8	48.3	130.1	12.7	30.4	166.8	34.1	11.2	0.5	308.6
Lunsklip Granite	8.2	61.6	480.9	33.4	15.8	76.1	1.7	20.7	38.9	14.4	7.0	1.6	219.6
Matlala Granite	7.9	198.0	1280.4	97.3	60.6	218.0	6.2	30.5	397.5	41.7	22.3	1.5	275.5
Matoks Granite	8.3	168.9	1118.8	83.1	53.4	157.3	12.5	31.8	187.5	54.0	47.9	1.4	292.8
Moetsi Granite	7.9	74.0	530.9	28.9	27.8	76.8	5.8	34.2	70.4	25.5	15.3	0.8	194.9
Nebo Granites	8.0	191.0	1318.3	90.0	60.4	233.0	8.8	29.7	344.0	45.6	17.7	1.3	392.9
Quaternary	8.0	218.2	1399.5	96.9	88.2	215.2	9.1	29.6	462.1	53.0	14.6	0.5	332.6
Turfloop Granite	8.2	120.3	788.4	61.2	43.3	133.0	4.1	21.0	134.0	45.8	14.7	1.0	333.6
Volcanic Rocks	8.3	113.0	841.7	65.1	54.3	90.8	4.2	28.9	80.8	29.6	37.0	0.4	289.3
Waterberg Sediments	7.6	122.2	762.1	48.3	55.1	104.1	8.0	18.2	220.8	50.0	11.3	0.2	184.6
WMA2													
Bandeliers Complex	7.8	57.5	435.0	30.8	37.1	31.2	4.4	21.7	49.6	15.3	14.3	63.4	61.4
Biotite granite	7.8	74.0	510.0	40.5	27.9	68.6	2.0	23.2	91.6	12.6	7.4	33.0	199.0
Diabase	8.0	51.9	412.9	41.5	26.4	36.9	0.6	22.9	31.4	8.7	2.5	11.2	235.5
Giyani	7.8	108.5	791.1	54.7	70.6	72.7	2.1	17.0	101.3	33.2	6.6	26.1	390.9
Goudplaats Gneiss	7.9	117.2	811.9	60.7	54.7	98.9	4.4	24.4	160.7	20.7	13.2	42.6	273.9
Palmietfontein	8.0	56.8	426.6	41.5	31.6	20.8	3.9	25.4	43.2	10.7	7.0	19.1	199.8
Schiel Complex	8.0	77.1	547.9	59.8	31.5	38.3	3.0	31.5	58.2	11.9	10.5	32.5	188.3
Soutpansberg Lava	7.9	23.8	173.0	18.2	10.0	9.6	0.6	17.6	12.7	4.5	0.4	1.6	96.1

Comparing the mean chemical composition with regards to the different geological units (Table 10), two trends are noticeable. The most elevated concentrations based on the mean average concentration of the analyzed groundwater samples of the different chemical elements in WMA1 correlate with quaternary deposits and Nebo granites. The quaternary deposits occur mostly in the north of WMA1 (quaternary catchment A72A), which forms a discharge area. Groundwater flow from the Blouberg, Soutpansberg and from higher groundwater levels (elevated groundwater levels/recharge zones) in the south towards this area covered with quaternary deposits. This represents a highly mineralized groundwater type seen by the high concentrations of TDS, chloride and sodium. The Lunsklip (Mashashane) granite formation occurring in the south is part of the recharge area as the groundwater level gradient (elevated) groundwater levels/recharge area flow from south to north. This formation has the lowest concentration for most cations and anions as well as TDS contributing to refreshed groundwater. Therefore the concentrations of the different geological units with high concentration values are subjected to cation exchange reactions (as discussed with ion ratios) exchanging magnesium with sodium and calcium. Enriched chloride concentrations are from groundwater evolution.

WMA2 has two geological units with a high concentration and distribution of almost all cations and anions, i.e. the Giyani and Goudplaats gneiss geological units. Mineralogically these two areas do differ, as the Goudplaats gneiss consists mostly of pegmatoidal granites and gneiss (high grade metamorphism) while the Giyani complex (greenstone belt) consists of lavas and schist (intermediate grade metamorphism). The source of the high concentrations of the groundwater minerals is related to the highly weatherable minerals. The weathering products of these minerals give soils enriched in clay content, characterising slow groundwater percolation thus longer residence time in the unsaturated zone contributing to higher mineralized waters.

6.2.7 Groundwater quality hazards

The groundwater quality hazards i.e. ion concentrations above allowed maximum concentration according to the South African National Standards, indicating potential harmful concentrations for the study area, are summarized in Table 11.

Table 11: The number of samples per SANS 241 (2006) classes in both WMA's

SANS 241*	EC	TDS	Ca	Mg	Na	K	Cl	SO ₄	N	F
WMA1 (n=751 and n=652 for N)										
Class I	483	463	695	527	623	749	494	749	315	644
Class II	217	241	40	123	78	3	188	1	199	44
Above Class II	51	47	16	101	50	2	69	1	138	63
WMA2 (n=857)										
Class I	685	666	856	683	778	857	712	856	566	802
Class II	145	166	20	101	57	0	113	0	139	40
Above Class II	27	25	8	73	22	0	32	1	152	14

*SANS 241 (2006): South African National Standard for Drinking Water

The nitrate levels in both WMA focus areas are considerably high. A total of 31% of the analyzed 652 groundwater samples in WMA1 falls into Class II, which is the maximum allowable limit for limited duration. Another 21% of the total population falls above Class II, making it unacceptable for human consumption, leaving only 48% of the total population to fall onto Class I, the recommended operational limit for N (<10 mg/l). In WMA2 16% of the total population (n=857) fall into Class II which is maximum allowed limit for limited duration and 18% of the total population fall above Class II making it unacceptable for drinking standards leaving 66% of the total population to fall into Class I, recommended operational limit for N. The elevated nitrate levels are usually related to poor agricultural practices and poor sanitation facilities.

6.2.8 Isotope analysis

All groundwater samples collected during the hydrocensus were analysed for $\delta^{18}\text{O}$, $\delta^2\text{H}$ (deuterium) and $\delta^3\text{H}$ (tritium) to establish a better understanding of the recharge mechanisms as well as the groundwater age, supporting the development of a conceptual groundwater model. The isotope analyses are expressed in parts per thousand [‰] (Appendix B) with respect to the international standard VSMOW (Vienna Standard Mean Ocean Water).

The average $\delta^{18}\text{O}$ and $\delta^2\text{H}$ -values of -4.43 and -25.26 ‰ indicate a mostly light isotopic groundwater composition for the samples, i.e. depletion in the heavier isotopes.

Accordingly most of the water samples plot on a $\delta^2\text{H}$ versus $\delta^{18}\text{O}$ diagram (Figure 46) in close proximity to the global meteoric water line (GMWL: $\delta^2\text{H} = 8 * \delta^{18}\text{O} + 10$), which gives the long-term average isotopic composition of precipitation as reported by the International Atomic Energy Agency. A local meteoric waterline (LMWL: $\delta^2\text{H} = 8 * \delta^{18}\text{O} + 11.75$) with a d-excess of 11.75 is tentatively drawn in Figure 46, showing the inferred relatively light isotopic composition of precipitation in the catchments. This can be attributed to the higher latitude, and inland rain with a continuous depletion of heavier isotopes in the rainwater on its way from the ocean (Rayleigh

distillation), giving a lighter isotope signature to later inland precipitation events. Accordingly the groundwater samples collected in WMA 1 show a generally lighter isotopic composition compared to WMA 2, due to the increase rainout effect and/or altitude (altitude effects).

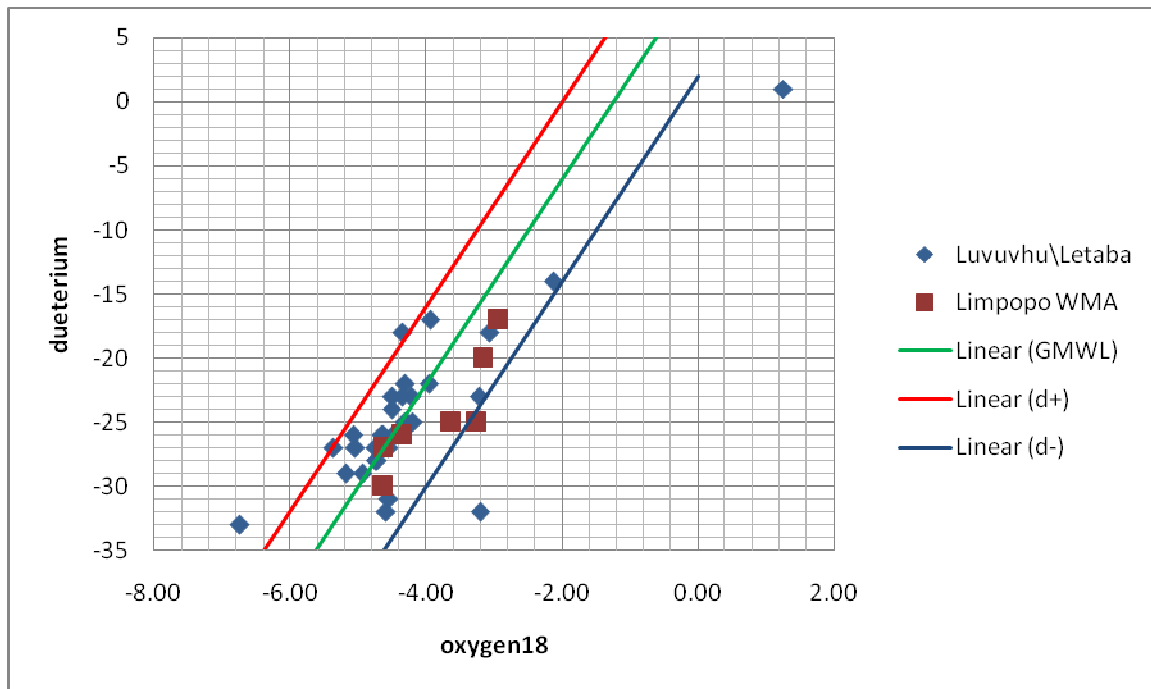


Figure 46: Isotope results from the groundwater samples

Since most of the groundwater samples plot close to these meteoric water lines, the water wasn't affected by evaporation prior to recharge, i.e. most of the aquifers were directly recharged by precipitation, either from the Soutpansberg mountain range or the escarpment towards Tzaneen. The average δ -values (Appendix B) clearly show the evaporative concentration of the heavier water isotopes in surface water bodies. Only a few samples (Figure 46) plot along a vaguely drawn evaporation or mixing line between the surface water samples and the LMWL, indicating varying contributions of evaporated surface water (indirect recharge) and directly recharged water to the groundwater resource.

Samples Chauke Unknown 001 (Nwamatatani / Majosi) and H17-0212 (Valdezia) don't follow this general trend and have a very light $\delta^2\text{H}$ isotope signature compared to the other samples in the region. A possible explanation for these isotope outliers might be upwelling of deeper groundwater along a geological discontinuity like a dolerite dyke. Although no dyke was visible in the field, the relatively high TDS value (802 mg/l for H17-0212 and 1260 mg/l for Chauke 001) of these samples support the hypothesis of deeper groundwater, which could be verified with geophysical methods.

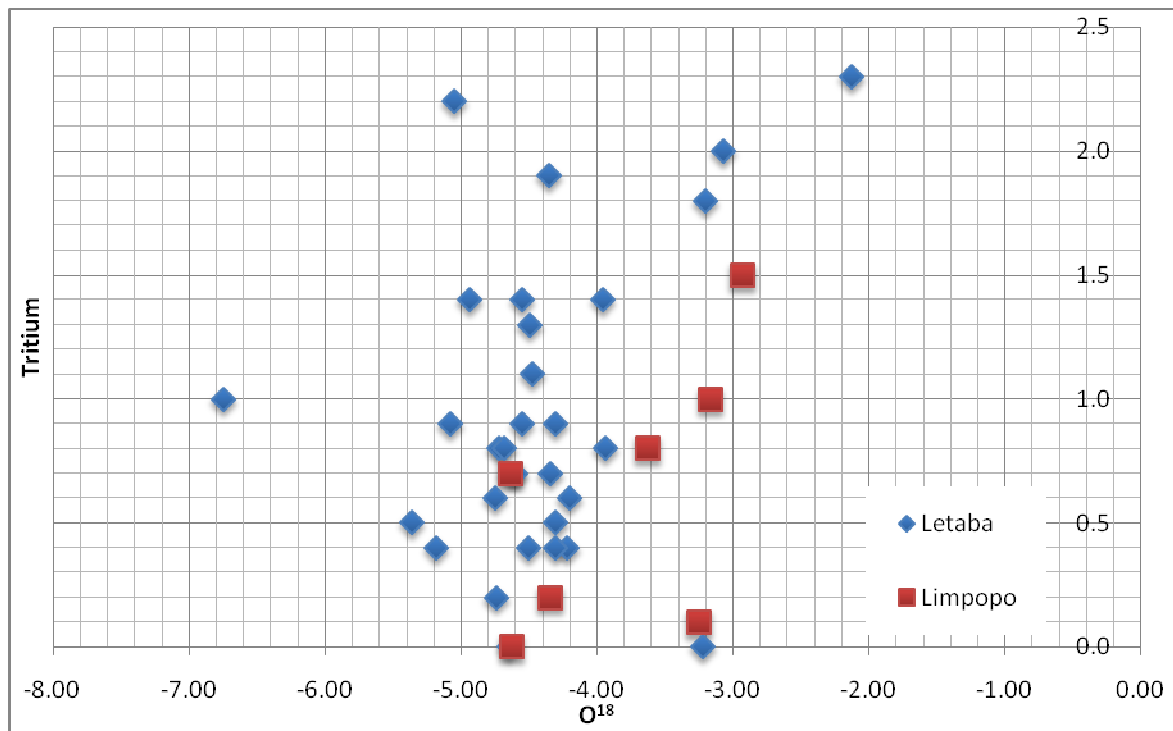


Figure 47: $\delta^{18}\text{O}$ and $\delta^2\text{H}$ concentration of WMA 1 and WMA 2

Most tritium analyses yielded values of up to 1TU and less (Figure 47 and Figure 48). Only 14 samples have TU values greater than 1, seven (7) of which yielded TU values between 1.5 and 2.3. The latter tritium data eventually point to some mixing of water components, as they do not represent recent rainfall values, but contain at least some older component. Samples with TU values < 1 most probably represent water with longer residence times such as several decades and more.

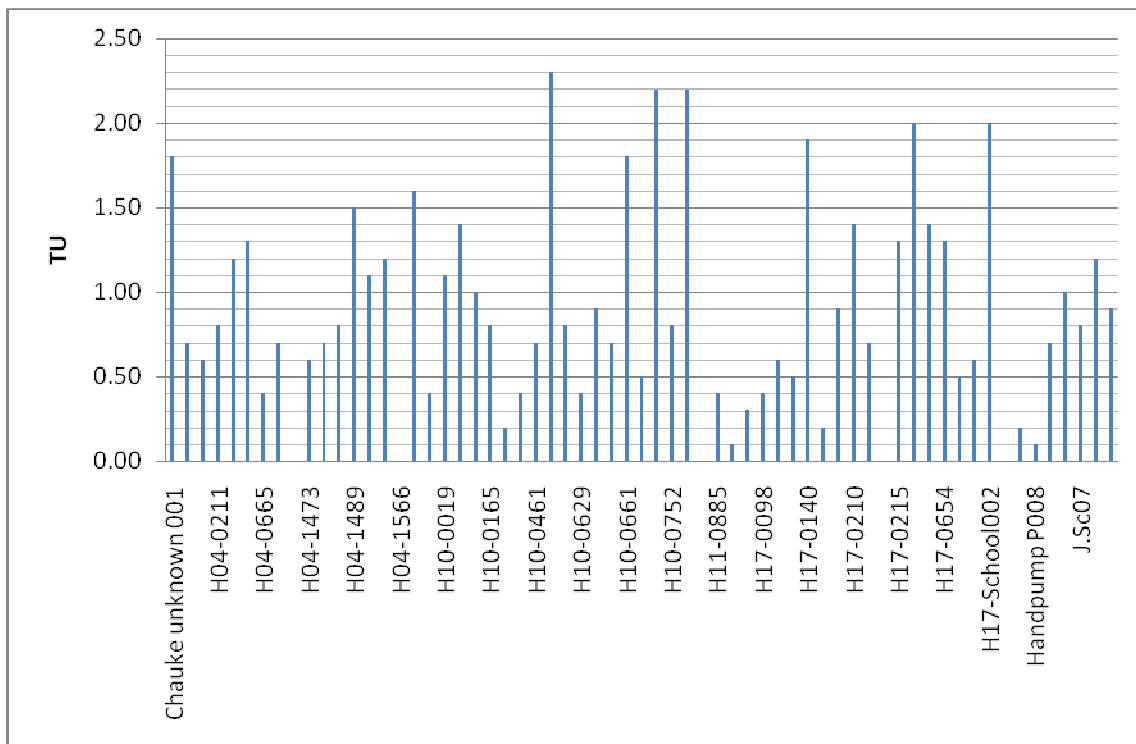


Figure 48: Tritium results for the groundwater samples

7 CONCLUSIONS

Groundwater characterisation and analysis provides the necessary means to understand the aquifer dynamics of basement rocks. The main objectives of this dissertation were to characterise the groundwater chemistry in the Limpopo and Letaba/Luvuvhu WMAs. The hypotheses tested were:

- The groundwater chemistry is a result of water-rock interaction (rock source) reactions involving both the weathered and unweathered aquifer material.
- The groundwater chemistry is influenced by hydrochemical processes such as cation exchange as well as near-surface processes such as evapotranspiration, dissolution and leaching processes.
- The groundwater chemical evolution can be related to dynamic/active groundwater flow systems or non-active groundwater flow systems within the weathered and fractured aquifer systems.

The chemical composition of groundwater occurring in hard crystalline rocks (basement rocks) is characterised by a dominant bicarbonate anion with low major ion concentrations. The dominant sodium-magnesium-bicarbonate (Na-Mg-HCO_3) typify most of the geological units, which result

from direct infiltration of evaporated rainwater in aquifers while decomposing carbonate at surface and carbonate dioxide originate from the atmosphere and percolate through the weathered and unweathered aquifer systems. This correlates well with the dominant water type results from the British Geological Society (BGS) and Rabemanana et al (2005) in similar basement rock aquifers. The British Geological Society (BGS) concluded that the weathered rocks show generally a Na-Cl or Na-HCO₃ water type with very low electrical conductivities (200µS/cm). The majority of samples represented newly recharged groundwater. Rabemanana et al (2005) concluded that bicarbonate is the dominant anion but with increased conductivity chloride became more dominant. They identified the following dominant groundwater types in the basement rocks in Madagascar; Na-HCO₃-Cl, Mg-HCO₃, Na-Cl-HCO₃ and Na-Cl.

In the study area Mg-Ca-HCO₃ enriched groundwater composition usually evolves through chemical and physical reactions to form a more mineralized sodium-chloride (Na-Cl) water type. Mg-HCO₃ enriched water types and low TDS values are associated with recharge areas located in the Blouberg, Soutpansberg and Tzaneen escarpment areas while Na-Cl water types with high TDS values are related to discharge areas. According to Titus (2003) Na-Cl dominant groundwater types in basement rocks in Namaqualand are associated with slower circulating, relatively older groundwater. Titus (2003) also noted that Na-Cl dominant waters are a result of either direct infiltration of Na-Cl precipitation or the dissolution and leaching of more soluble evaporitic salts. WMA 1 shows higher mineralization (higher TDS values) while elevated chloride concentrations, imply that the amount of recharge in comparison to WMA 2, influences the groundwater composition.

In the process of determining the origin of the groundwater composition within the different geological units, using the rock source deduction or ion ratio method, XRD and XRF and weathering factors a typical basement rock aquifer conceptual model (Figure 49), relating the geochemistry with these methodologies, was given. The conceptual geochemical model indicates flow directions from the higher elevated areas towards the lower lying areas. In the Limpopo WMA groundwater flow is mostly in a northern direction. In Letaba\Luvuvhu WMA the main groundwater flow direction is in a north westerly direction. Localized groundwater flow direction from the Blouberg, Soutpanberg, Tzaneen escarpment and inselbergs influence the flow only on a local scale. From the isotope analysis a light isotopical composition and unrelated evaporation signature indicate that most of the aquifers were directly recharged by precipitation, either from direct rainfall or from the Soutpansberg mountain range and the escarpment towards Tzaneen. It is along these flow systems that weathering of rocks releases major cations into the solution. The groundwater evolves through cation exchange reactions, dissolution, evaporation, and salt flushing together with

other unidentified factors forming a more mineralized groundwater type. A typical groundwater facie Mg-Na-HCO_3 (fresh groundwater) evolves into a Na-Cl (mineralized groundwater).

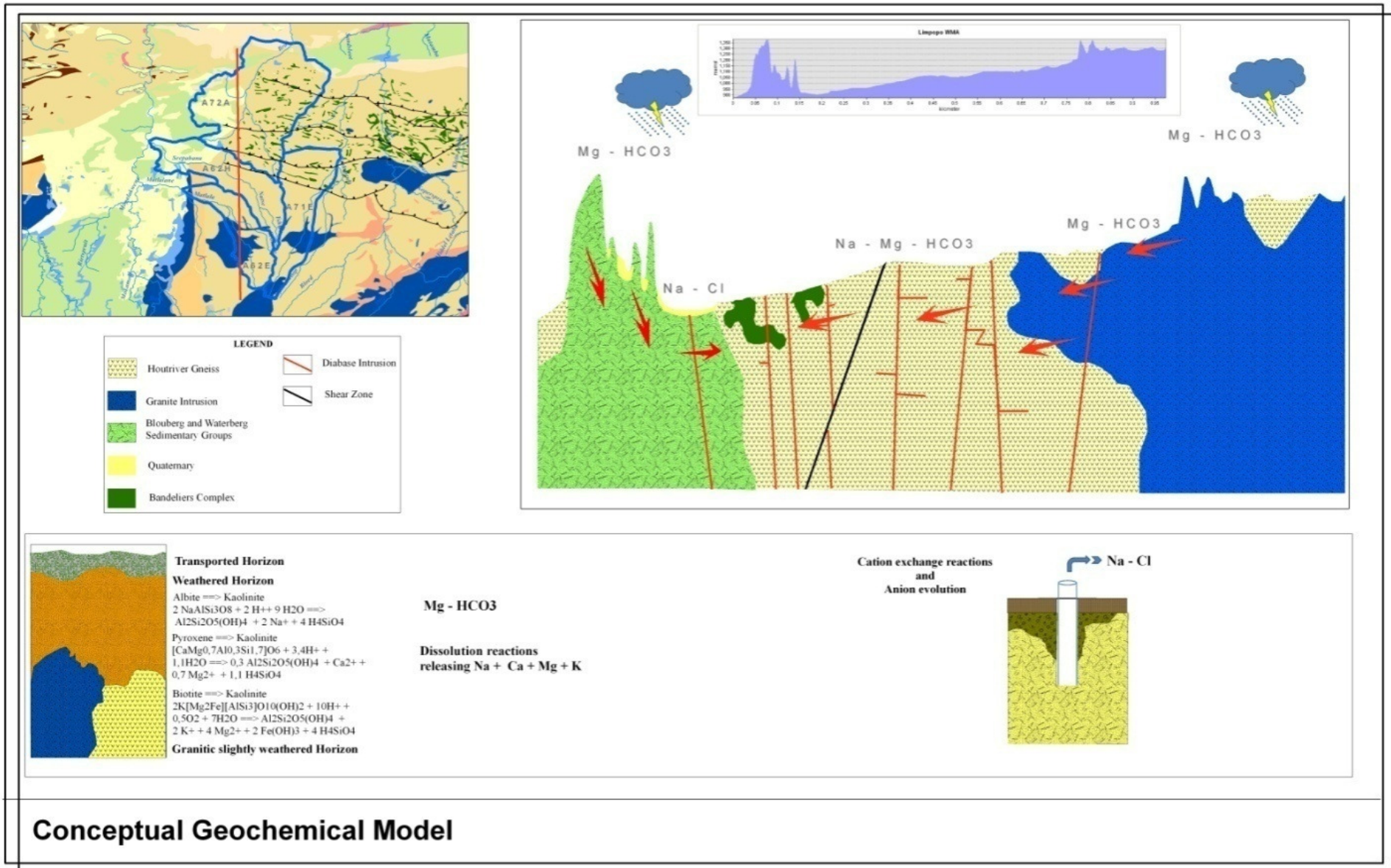


Figure 49: Conceptual model representing the groundwater evolution, flow and dominant groundwater types

However, from the ion ratios and weathered factors only a small percentage (12%) of the total groundwater samples' origin correlates with the applied methodologies. Regarding the major cations, the weathering of plagioclase, an abundant mineral in all of the analysed rock types, forms kaolinite, releasing all major cations into the system. Therefore, relating the groundwater chemistry with weathering products seems to be inconclusive. This may imply that other factors, that still need to be investigated, play a large part in the groundwater chemistry's composition. It is therefore evident that the groundwater chemistry doesn't only originate from weathering of or the mineralogy of host rocks but are influenced by other factors altering the groundwater chemistry.

Recommendations:

- To improve the study and improve the level of confidence on the groundwater composition, and site specific, e.g. well field, locations in different geological units should be concentrated on.
- Accurate borehole data and up to date chemical quality data need to be retrieved.
- Correlation between the borehole depth, weathering depth and groundwater sample point is essential in the analysis to determine groundwater quality in deep unweathered or shallower weathered aquifer systems.
- Groundwater age dating techniques, other than natural isotopes, such as CFC need to be incorporated for more accurate dating of the groundwater.
- The fractures present in the crystalline basement aquifer system need to be modelled to understand groundwater flow in these systems.
- The study of dolomite domains or dolomite compartments should also be incorporated in the groundwater flow system and recharge environment.
- Chloride soil samples should be taken at different depths in the weathered aquifer system in each geological units/formation to give a more reliable understanding of recharge in the weathered zone.

In conclusion, characterization of the groundwater chemistry of the basement rock aquifers in Limpopo and Letaba/Luvuvhu WMA's rocks could not establish the different groundwater facies (origin). The origin of the groundwater in each geological unit /formation and the basement aquifer as a whole is still not completely clear due to a number of functions. These include: complexity and lack of understanding groundwater flow (i.e. either shallow or deeper circulating groundwater), variability in weathered profiles and the diverse mineralogy. Further investigation with e.g. CFC methods to determine the groundwater age and aquifer parameters may lead to a better understanding and conceptualizing of basement aquifer groundwater chemistry on a localized scale.

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APPENDIX A: CHEMICAL ANALYSIS

Borehole nr.	Water type	X	Y	pH	EC	TDS	Ca	Mg	Na	K	Si	Cl	SO4	N	NO3	F	HCO3
H03-0105	Na-Cl	28.8235744	-23.5504547	8.08	244.00	1522.11	130.51	96.86	184.95	3.73	41.62	400.20	40.59	9.95	44.05	0.43	620.75
H03-0129	Na-Cl	28.6603880	-23.4120547	8.09	254.00	1554.67	71.66	109.70	254.27	1.00	43.20	490.56	32.72	16.80	74.37	0.61	519.67
H03-0129	Na-Cl	28.6603880	-23.4120547	8.09	254.00	1554.67	71.66	109.70	254.27	1.00	43.20	490.56	32.72	16.80	74.37	0.61	519.67
H03-0144	Mg-HCO3	28.6874700	-23.4880547	7.97	153.00	1069.26	71.45	81.69	110.52	2.16	39.13	151.26	24.40	23.56	104.30	0.61	522.71
H03-0156	Na-Cl	28.7372020	-23.5120772	7.85	694.00	4163.62	242.95	272.70	806.45	31.74	39.09	1990.35	192.76	21.95	97.17	0.36	529.05
H03-0166	Na-HCO3	28.8730158	-23.5574043	8.35	178.00	1517.29	39.53	31.61	333.98	10.39	35.78	47.98	71.84	10.19	45.11	1.64	935.08
H03-0173	Na-HCO3	28.8303945	-23.5859223	8.47	144.00	998.93	58.78	52.15	150.94	10.51	39.68	177.99	15.10	10.54	46.66	1.46	485.21
H03-0175	Ca-HCO3	28.8077438	-23.5787927	8.10	101.30	834.00	82.00	43.00	83.00	5.40	40.20	115.00	9.00	16.41	72.64	0.40	423.10
H03-0621	Na-Cl	28.7910737	-23.4215735	8.18	344.00	2179.69	64.80	66.25	524.74	14.32	39.09	613.56	149.76	41.96	185.75	0.88	559.54
H03-0912	Mg-Cl	28.7069611	-23.4912686	7.82	201.00	1198.00	123.71	90.87	125.54	4.26	25.08	367.31	42.81	15.07	66.71	0.44	376.32
H03-0964	Ca-HCO3	28.8181643	-23.5399654	8.30	151.00	1041.00	124.00	73.00	71.00	2.40	42.20	211.00	24.00	13.56	60.03	0.39	475.53
H03-1021	Mg-HCO3	28.6616196	-23.4824091	7.88	124.90	951.06	94.38	63.34	67.79	1.14	43.61	96.91	17.91	46.72	206.82	0.62	401.95
H03-1021	Mg-HCO3	28.6616196	-23.4824091	7.88	124.90	951.06	94.38	63.34	67.79	1.14	43.61	96.91	17.91	46.72	206.82	0.62	401.95
H03-1023	Mg-HCO3	28.7102500	-23.4611377	7.98	90.10	715.59	71.44	48.19	49.28	1.12	35.58	49.02	15.57	17.27	76.45	0.35	404.04
H03-1057	Mg-HCO3	28.8129701	-23.5705523	8.19	155.00	1070.04	96.10	71.74	71.74	6.93	39.23	178.00	17.49	18.40	81.45	0.46	514.67
H03-1094	Na-Cl	28.8302446	-23.5626739	8.06	426.00	2618.91	97.81	117.55	610.64	23.51	39.66	1024.49	67.82	7.44	32.94	1.97	642.08
H03-1158	Ca-HCO3	28.6813798	-23.7212727	8.30	95.10	722.00	86.00	40.00	57.00	2.80	40.00	77.00	6.00	21.39	94.69	0.40	359.69
H03-1161	Ca-Cl	28.7766222	-23.8607134	8.10	249.00	1655.00	200.00	74.00	199.00	6.40	34.60	507.00	42.00	41.28	182.74	1.40	442.61
H03-1161	Ca-Cl	28.7766222	-23.8607134	8.10	249.00	1655.00	200.00	74.00	199.00	6.40	34.60	507.00	42.00	41.28	182.74	1.40	442.61
H03-1237	Ca-HCO3	28.6812995	-23.8407045	8.10	97.60	715.00	97.00	32.00	60.00	1.70	26.10	170.00	7.00	6.23	27.58	0.20	319.46
H03-1325	Na-HCO3	28.7526727	-23.4121541	7.74	237.00	1641.53	138.93	78.08	201.10	10.85	42.29	256.69	56.72	99.64	441.09	0.57	457.42
H03-1329	Na-Cl	28.7513900	-23.4113897	8.05	289.00	1828.85	95.09	76.55	370.73	11.91	39.74	576.75	75.06	17.85	79.02	0.94	542.71
H03-1366	Na-HCO3	28.7172770	-23.6853052	8.30	74.00	732.00	66.00	34.00	80.00	3.80	34.60	20.00	13.00	15.72	69.59	0.58	445.04
H03-1499	Na-HCO3	28.8781861	-23.5317061	8.53	179.00	1507.71	38.50	32.94	325.24	10.36	34.99	46.16	73.45	9.02	39.93	1.56	939.47
H03-1530	Mg-Cl	28.6737302	-23.4756596	7.63	257.00	1611.53	127.93	120.98	197.06	1.41	39.24	416.28	31.67	26.10	115.54	0.57	600.02
H03-1532	Na-HCO3	28.9291274	-23.5777930	8.10	161.00	1156.00	82.00	51.00	164.00	51.40	34.10	228.00	31.00	25.26	111.82	0.50	435.29
H03-1534	Mg-HCO3	28.9719073	-24.1809720	8.20	193.00	1400.00	55.00	135.00	154.00	0.70	27.90	215.00	52.00	14.85	65.74	0.29	723.04
H03-1566	Na-HCO3	28.8349647	-23.5729532	8.40	104.40	823.00	48.00	50.00	101.00	11.40	35.30	85.00	21.00	15.46	68.44	1.49	436.51
H03-1603	Na-HCO3	28.7721021	-23.8715426	8.20	114.90	956.00	64.00	37.00	158.00	1.70	31.90	103.00	24.00	7.35	32.54	1.00	535.27
H03-1604	Na-HCO3	28.7720821	-23.8708527	8.10	110.40	894.00	71.00	37.00	130.00	2.00	32.90	109.00	16.00	4.86	21.51	0.90	506.01
H03-1605	Na-HCO3	28.7691620	-23.8741924	8.10	138.00	1064.00	61.00	44.00	192.00	1.80	28.50	152.00	37.00	7.15	31.65	1.00	543.81
H03-1610	Na-HCO3	28.7808924	-23.8619833	8.30	96.90	772.00	53.00	28.00	125.00	1.60	30.00	80.00	20.00	6.99	30.94	1.12	432.85
H03-1610	Na-HCO3	28.7808924	-23.8619833	8.30	96.90	772.00	53.00	28.00	125.00	1.60	30.00	80.00	20.00	6.99	30.94	1.12	432.85
H03-1611	Na-HCO3	28.7768423	-23.8612633	8.10	106.40	826.00	69.00	34.00	115.00	2.10	28.40	102.00	15.00	6.80	30.10	0.86	458.46
H03-1615	Na-HCO3	28.7741221	-23.8607134	8.30	147.00	1142.00	85.00	51.00	187.00	0.60	40.00	192.00	9.00	9.12	40.37	2.00	575.51
H03-1621	Na-Cl	28.7480014	-23.8658930	8.00	159.00	1093.00	121.00	45.00	144.00	3.90	36.60	231.00	27.00	59.81	264.77	1.20	254.83
H03-1623	Na-Cl	28.7532116	-23.8571036	7.90	146.00	1002.00	111.00	39.00	131.00	3.80	27.30	232.00	15.00	36.29	160.65	1.90	307.26
H03-1624	Na-Cl	28.7493815	-23.8568836	8.00	149.00	1045.00	109.00	56.00	134.00	3.40	31.10	252.00	20.00	10.63	47.06	1.70	421.88
H03-1626	Ca-Cl	28.7548017	-23.8547237	7.70	185.00	1177.00	150.00	47.00	160.00	0.60	24.20	344.00	30.00	11.77	52.10	2.60	390.18
H03-1627	Mg-HCO3	28.7613118	-23.8597534	8.10	63.30	461.00	41.00	27.00	51.00	2.30	39.40	45.00	5.00	5.29	23.42	0.30	265.81
H03-1628	Na-HCO3	28.7599618	-23.8087769	8.20	144.00	1236.00	55.00	58.00	216.00	0.30	33.90	109.00	10.00	5.62	24.88	1.20	762.06
H03-1631	Mg-HCO3	28.7471415	-23.8230259	8.10	113.80	889.00	79.00	54.00	97.00	1.00	33.50	97.00	12.00	12.82	56.75	1.00	491.38
H03-1636	Mg-HCO3	28.8237737	-23.8317454	8.20	95.00	782.00	63.00	46.00	82.00	4.70	34.30	47.00	15.00	19.21	85.04	0.30	438.95
H03-1637	Na-HCO3	28.8076932	-23.8450945	8.10	105.10	877.00	85.00	42.00	106.00	2.10	28.70	103.00	20.00	7.45	32.98	0.70	485.28
H03-1639	Na-HCO3	28.8075732	-23.8460544	8.00	97.00	820.00	78.00	42.00	95.00	2.50	27.50	83.00	19.00	6.67	29.53	0.60	470.65

Borehole nr.	Water type	X	Y	pH	EC	TDS	Ca	Mg	Na	K	Si	Cl	SO4	N	NO3	F	HCO3
H03-1640	Na-HCO3	28.8049732	-23.8445945	8.30	122.40	931.00	79.00	30.00	153.00	1.50	27.70	171.00	19.00	3.65	16.16	1.34	459.68
H03-1641	Na-HCO3	28.8022131	-23.8424347	8.10	171.00	1241.00	107.00	37.00	221.00	1.10	30.60	265.00	23.00	6.96	30.81	1.30	553.56
H03-1652	Ca-HCO3	28.7167909	-23.7260724	7.90	62.80	480.00	56.00	27.00	33.00	1.60	23.40	41.00	9.00	4.40	19.48	0.40	293.85
H03-1695	Mg-HCO3	28.9480169	-24.0554205	8.20	101.40	930.00	60.00	109.00	14.00	0.50	33.30	18.00	27.00	26.25	116.20	0.25	586.48
H03-1696	Mg-HCO3	28.9456268	-24.0532006	8.20	186.00	1416.00	94.00	178.00	19.00	0.90	35.90	107.00	42.00	89.23	395.00	0.20	579.17
H03-1697	Mg-HCO3	28.9416267	-24.0537206	8.10	168.00	1338.00	95.00	163.00	19.00	1.10	33.90	88.00	49.00	89.37	395.62	0.24	526.74
H03-1698	Mg-HCO3	28.9427367	-24.0482710	7.90	100.00	944.00	99.00	86.00	7.00	0.40	32.70	11.00	12.00	1.86	8.23	0.20	719.39
H03-1699	Mg-HCO3	28.9412367	-24.0448512	8.00	98.20	917.00	92.00	86.00	8.00	1.00	28.50	13.00	12.00	0.65	2.88	0.20	701.10
H03-1700	Mg-HCO3	28.9426767	-24.0461011	8.50	100.90	903.00	95.00	79.00	13.00	0.80	30.20	27.00	14.00	0.87	3.85	0.33	669.40
H03-1704	Mg-HCO3	28.9538571	-24.0165331	8.10	100.20	913.00	78.00	88.00	21.00	4.70	34.00	17.00	6.00	5.53	24.48	0.20	675.49
H03-1706	Mg-HCO3	28.9492170	-24.0139533	8.50	86.40	803.00	54.00	82.00	28.00	3.40	31.00	18.00	8.00	2.60	11.51	0.21	597.46
H03-1709	Mg-HCO3	28.9605173	-24.0165331	8.00	56.80	443.00	31.00	39.00	23.00	8.60	11.20	39.00	10.00	0.35	1.55	0.20	291.41
H03-1711	Mg-HCO3	28.9581973	-24.0154832	8.50	95.50	841.00	31.00	83.00	71.00	4.40	45.20	75.00	8.00	2.74	12.13	0.37	556.00
H03-1731	Mg-HCO3	28.7792329	-23.6241596	8.20	120.90	1074.00	96.00	66.00	103.00	2.20	32.50	132.00	7.00	10.63	47.06	0.41	619.40
H03-1731	Mg-HCO3	28.7792329	-23.6241596	8.20	120.90	1074.00	96.00	66.00	103.00	2.20	32.50	132.00	7.00	10.63	47.06	0.41	619.40
H03-1735	Mg-HCO3	28.7724927	-23.6278493	8.30	87.50	788.00	69.00	51.00	70.00	2.40	35.50	45.00	7.00	5.24	23.20	0.41	520.64
H03-1743	Na-Cl	28.7399318	-23.6262793	8.10	215.00	1338.00	132.00	55.00	225.00	1.60	22.50	480.00	10.00	5.49	24.30	1.71	408.47
H03-1745	Na-Cl	28.7377117	-23.6364986	8.00	157.00	1055.00	112.00	39.00	153.00	2.30	36.70	244.00	9.00	40.45	179.06	0.38	315.80
H03-1747	Na-HCO3	28.7353516	-23.6428582	8.10	164.00	1263.00	46.00	67.00	232.00	2.10	32.50	179.00	25.00	19.22	85.08	0.89	625.50
H03-1752	Na-Cl	28.7255114	-23.5546242	8.50	193.00	1209.00	76.00	60.00	216.00	0.90	36.90	303.00	18.00	21.80	96.50	1.74	437.73
H03-1756	Mg-HCO3	28.7142713	-23.5331357	7.77	119.10	817.54	90.96	56.88	63.39	2.13	33.06	203.15	4.36	7.64	33.82	0.31	362.40
H03-1784	Mg-HCO3	28.6816893	-23.9410277	8.10	64.10	501.92	38.11	32.63	46.02	1.06	10.94	42.76	9.27	0.72	3.19	0.28	328.13
H03-1801	Na-Cl	28.8460850	-23.5722433	8.07	444.00	2838.15	111.19	123.61	635.15	24.97	38.38	1043.60	85.50	19.13	84.68	2.14	727.19
H03-1803	Na-Cl	28.8417249	-23.5721533	8.10	608.00	4146.00	129.00	201.00	922.00	49.10	37.20	1513.00	236.00	15.83	70.08	1.70	1024.21
H03-1826	Mg-HCO3	28.9841476	-24.1679329	7.96	122.70	955.87	73.29	103.13	39.22	0.82	26.07	80.93	51.01	21.89	96.90	0.21	510.28
H03-1850	Ca-Cl	28.6810595	-23.8379847	7.80	160.00	1075.00	141.00	72.00	98.00	1.50	28.50	289.00	10.00	6.13	27.14	0.30	435.29
H03-1856	Ca-HCO3	28.6870897	-23.8585333	8.10	141.00	986.00	128.00	51.00	70.00	2.10	24.60	165.00	17.00	26.00	115.10	0.80	437.73
H03-1859	Ca-HCO3	28.6952397	-23.8501539	7.70	125.70	967.00	135.00	47.00	72.00	0.90	23.50	124.00	31.00	54.38	240.73	0.90	315.80
H03-1874	Ca-HCO3	28.6826796	-23.8316052	8.20	113.00	789.00	78.00	44.00	85.00	2.10	34.20	166.00	22.00	6.90	30.54	0.63	360.91
H03-1945	Na-HCO3	28.6682791	-23.8758821	8.50	56.80	446.00	38.00	6.00	77.00	0.80	20.60	29.00	5.00	0.43	1.90	1.86	284.10
H03-1947	Ca-HCO3	28.6676591	-23.8756821	8.30	64.30	465.00	58.00	16.00	46.00	1.70	20.60	49.00	5.00	9.03	39.97	1.86	247.52
H03-1954	Ca-HCO3	28.6761693	-23.8796619	8.10	116.40	834.00	114.00	39.00	54.00	1.60	25.90	127.00	15.00	30.49	134.97	1.00	346.28
H03-1954	Ca-HCO3	28.6761693	-23.8796619	8.10	116.40	834.00	114.00	39.00	54.00	1.60	25.90	127.00	15.00	30.49	134.97	1.00	346.28
H03-1972	Ca-HCO3	28.7112403	-23.9029304	7.70	96.60	715.00	91.00	17.00	84.00	3.00	23.00	77.00	12.00	48.77	215.90	1.70	213.38
H03-2033	Na-Cl	28.7756021	-23.9343984	8.20	218.00	1584.00	142.00	109.00	217.00	2.50	31.90	499.00	103.00	19.87	87.96	0.24	424.32
H03-2061	Mg-HCO3	28.8222035	-23.8998608	8.10	111.30	978.00	66.00	72.00	103.00	5.40	37.20	134.00	34.00	18.90	83.67	0.34	480.40
H03-2075	Ca-Cl	28.8591244	-23.9832052	7.90	171.00	1029.00	152.00	80.00	57.00	0.70	32.40	342.00	15.00	9.68	42.85	0.18	338.97
H03-2200	Ca-HCO3	28.7177303	-23.9048702	8.30	51.80	428.00	55.00	6.00	51.00	1.00	17.80	19.00	8.00	0.04	0.18	2.90	285.32
H03-2461	Mg-HCO3	28.8204643	-23.5678135	8.18	126.50	974.64	84.56	61.21	100.42	6.60	39.68	139.48	14.29	18.12	80.21	0.46	487.07
H03-2463	Na-Cl	28.8310147	-23.5206968	7.99	403.00	2593.91	92.99	95.33	618.65	23.16	35.72	889.53	208.22	11.39	50.42	0.94	614.53
H03-2465	Na-HCO3	28.8366248	-23.5248965	8.29	293.00	2182.17	20.79	23.44	620.42	11.89	35.73	399.22	97.29	10.84	47.99	2.64	958.37
H03-2482	Na-HCO3	28.6609197	-23.5138069	7.71	211.00	1338.40	119.31	72.72	184.23	1.73	39.21	315.13	17.12	16.72	74.02	1.25	549.78
H03-2482	Na-HCO3	28.6609197	-23.5138069	7.71	211.00	1338.40	119.31	72.72	184.23	1.73	39.21	315.13	17.12	16.72	74.02	1.25	549.78
H03-2485	Mg-HCO3	28.6966306	-23.5708831	7.27	142.10	954.00	121.80	77.10	71.00	3.10	0.00	219.90	15.30	7.75	34.31	0.15	498.69
H03-2486	Na-HCO3	28.7377720	-23.5129271	8.35	155.00	1101.77	64.26	65.31	158.29	1.03	34.85	164.98	38.46	20.43	90.44	0.36	518.45

Borehole nr.	Water type	X	Y	pH	EC	TDS	Ca	Mg	Na	K	Si	Cl	SO4	N	NO3	F	HCO3
H03-2489	Na-HCO3	28.6757603	-23.4758295	8.43	199.00	1395.10	91.28	88.07	180.61	1.20	44.66	251.30	31.55	23.54	104.21	0.54	646.23
H03-2499	Na-HCO3	28.8313748	-23.4898989	8.10	102.10	677.03	51.96	29.48	110.02	4.05	39.16	113.95	31.25	10.15	44.93	1.38	289.89
H03-2499	Na-HCO3	28.8313748	-23.4898989	8.10	102.10	677.03	51.96	29.48	110.02	4.05	39.16	113.95	31.25	10.15	44.93	1.38	289.89
H03-2529	Na-Cl	28.7483226	-23.4083444	8.09	315.00	2035.96	72.93	65.67	489.54	8.94	38.98	606.89	83.74	19.80	87.65	1.56	618.79
H03-2531	Na-HCO3	28.7408330	-23.3847220	8.23	224.00	1604.68	14.18	23.95	414.98	13.55	44.22	207.06	64.05	55.45	0.00	1.21	620.14
H03-2535	Ca-Cl	28.7478050	-23.4530547	8.05	332.00	1689.49	225.40	131.24	182.28	2.99	22.11	919.46	4.97	9.45	41.83	0.24	180.21
H03-2548	Na-Cl	28.7427600	-23.3978300	8.15	410.00	2615.13	83.97	111.21	626.46	24.83	41.18	886.44	159.97	17.83	0.00	0.65	642.57
H03-2577	Mg-HCO3	28.9540550	-24.1351937	8.50	121.00	1001.00	63.00	95.00	72.00	3.40	35.10	111.00	19.00	10.00	44.27	0.46	581.61
H03-2578	Mg-HCO3	28.9110658	-24.0297822	8.30	85.10	882.00	50.00	90.00	47.00	1.50	28.80	19.00	15.00	14.73	65.21	0.27	593.80
H03-2580	Na-HCO3	28.9078259	-23.9684363	8.10	73.00	686.00	45.00	37.00	83.00	3.10	3.10	24.00	97.00	20.46	90.57	0.31	306.04
H03-2586	Mg-HCO3	28.9292021	-24.1205960	8.66	89.10	738.61	44.58	51.52	77.64	1.34	34.41	33.59	23.36	6.99	30.94	0.38	475.16
H03-2594	Mg-Cl	28.8056550	-23.9977874	8.24	472.00	2891.10	323.12	234.75	286.35	7.82	36.90	1230.90	230.10	31.64	140.06	0.37	437.59
H03-2602	Mg-Cl	28.8020438	-23.9973430	7.97	507.00	3031.80	361.24	263.77	283.51	7.96	38.25	1390.30	264.58	10.92	48.34	0.38	411.53
H03-2603	Mg-HCO3	28.8728248	-24.0062837	8.37	109.70	806.97	89.81	63.51	28.40	4.43	36.96	107.57	40.30	31.30	138.55	0.20	334.26
H03-2605	Mg-HCO3	28.9510201	-24.1476109	8.42	109.20	828.90	46.05	74.88	64.82	0.87	32.40	86.93	13.01	15.27	67.58	0.99	473.65
H03-2739	Mg-Cl	28.8316660	-23.8716657	8.00	263.00	1580.00	147.00	141.00	138.00	5.20	32.10	533.00	114.00	28.91	127.98	0.16	373.11
H03-2740	Mg-Cl	28.8322220	-23.8705547	8.40	177.00	1267.00	106.00	113.00	130.00	5.30	31.30	357.00	84.00	18.24	80.74	0.27	391.40
H03-2774	Mg-HCO3	28.8252404	-23.5679555	6.95	117.30	1017.00	98.30	92.30	138.10	7.13	0.00	215.60	18.20	17.13	75.83	0.25	638.30
H03-2776	Mg-HCO3	28.8276445	-23.5695534	6.98	118.00	1022.00	96.30	86.90	138.70	7.02	0.00	220.50	16.80	17.59	77.87	0.25	648.91
H03-2861	Ca-HCO3	28.8318098	-23.4824949	8.21	97.70	690.02	72.02	37.22	66.47	4.63	39.93	113.92	38.67	20.84	92.25	0.78	263.92
H03-2870	Na-HCO3	28.6960714	-23.1901993	8.02	25.40	161.68	15.11	4.70	20.53	3.91	4.45	21.48	7.08	0.56	2.48	0.36	85.93
H03-3007	Na-HCO3	28.8013800	-23.4244400	8.68	105.80	892.87	65.58	43.09	112.12	7.57	41.32	98.95	19.96	13.08	0.00	0.98	486.58
H03-3041	Na-HCO3	28.9609375	-23.9554017	8.36	88.40	659.74	60.26	28.15	86.49	1.22	22.67	61.79	15.10	17.12	75.77	0.43	330.48
H03-3042	Na-HCO3	28.9633776	-23.9495677	8.23	94.80	802.92	57.87	29.48	120.79	0.94	29.27	83.07	11.17	2.83	12.54	0.43	486.54
H03-3045	Na-HCO3	28.9837992	-23.9728728	8.39	105.40	867.99	41.27	22.26	180.69	0.92	28.20	141.84	9.25	0.91	4.04	1.11	466.50
H03-3047	Na-HCO3	29.0129113	-23.9442082	8.22	110.40	928.03	72.60	52.18	126.58	3.10	34.00	149.26	25.95	10.07	44.56	0.35	453.34
H03-3051	Na-HCO3	28.9637153	-23.9676787	8.01	85.90	739.72	56.49	34.76	103.21	1.69	26.83	82.12	25.35	3.98	17.62	0.55	417.70
H03-3051	Na-HCO3	28.9637153	-23.9676787	8.01	85.90	739.72	56.49	34.76	103.21	1.69	26.83	82.12	25.35	3.98	17.62	0.55	417.70
H03-3053	Na-HCO3	28.9801047	-23.9807334	8.34	112.00	1059.53	42.83	37.97	196.57	5.90	21.75	76.68	20.28	0.07	0.31	1.82	676.83
H03-3055	Ca-Cl	28.9691877	-23.9690953	7.86	109.60	790.11	110.42	49.41	85.20	4.95	24.32	164.29	97.72	3.98	17.62	0.32	260.02
H03-3070	Na-HCO3	28.9854937	-23.9700675	7.52	66.60	599.00	30.84	17.91	106.46	1.20	29.90	52.67	12.43	0.06	0.26	1.19	375.85
H03-3072	Na-HCO3	28.9832992	-23.9733450	7.53	66.30	595.21	29.43	16.46	110.03	0.85	28.33	59.14	13.18	0.24	1.06	1.27	363.56
H03-3073	Na-HCO3	28.9800213	-23.9804279	8.38	146.00	1080.69	26.26	20.63	238.13	3.38	29.83	114.19	11.22	1.01	4.47	4.05	658.18
H03-3092	Na-HCO3	28.8813252	-23.9162298	8.26	155.00	1121.33	58.05	50.79	194.29	2.82	34.14	194.66	36.08	0.53	2.34	0.99	581.24
H03-3146	Mg-NO3	28.8447952	-23.9347085	8.08	255.00	1828.04	113.93	179.13	118.05	8.69	35.24	223.42	102.31	137.68	609.48	0.25	472.56
H04-0016	Na-HCO3	29.4069722	-23.7011657	7.18	59.70	351.00	27.00	24.20	60.80	5.50	30.90	47.90	14.60	12.40	54.89	0.51	255.20
H04-0017	Mg-HCO3	29.4122500	-23.7072217	7.11	50.60	289.00	19.80	25.10	38.50	3.50	0.06	33.00	15.00	17.30	76.58	0.45	198.87
H04-0021	Na-HCO3	28.9812000	-23.3972097	7.82	93.70	760.40	44.34	35.63	99.88	16.23	15.88	76.70	4.00	0.09	0.40	0.23	482.44
H04-0024	Na-HCO3	29.2993300	-23.7393300	8.29	105.30	827.82	48.62	25.03	158.47	0.77	38.88	153.75	34.90	21.18	0.00	2.69	309.67
H04-0049	Na-HCO3	29.2791670	-23.7594440	8.32	78.60	573.39	37.12	17.34	100.46	6.15	28.49	92.43	18.09	8.72	0.00	2.22	260.91
H04-0053	Na-HCO3	29.3625000	-23.7361092	7.93	105.90	804.83	39.06	33.09	146.44	5.77	22.81	117.69	27.22	22.79	100.89	1.24	333.39
H04-0061	Na-HCO3	29.2461110	-23.6777780	8.08	74.00	521.31	25.52	20.12	92.29	4.23	38.47	52.25	12.79	13.62	0.00	0.54	253.21
H04-0066	Na-HCO3	29.2052700	-23.6320500	7.95	100.90	714.96	52.04	21.83	107.49	31.21	34.13	152.18	28.98	4.86	0.00	0.34	298.76
H04-0069	Na-HCO3	29.1625500	-23.6169600	8.27	84.60	703.23	41.45	22.87	129.78	4.98	38.31	99.75	20.20	9.78	0.00	0.53	340.25
H04-0072	Na-HCO3	29.1481100	-23.6103900	8.16	71.80	563.59	14.82	14.61	127.52	7.68	3.70	80.38	7.42	0.06	0.00	0.46	310.41

Borehole nr.	Water type	X	Y	pH	EC	TDS	Ca	Mg	Na	K	Si	Cl	SO4	N	NO3	F	HCO3
H04-0072	Na-HCO3	29.1481100	-23.6103900	8.16	71.80	563.59	14.82	14.61	127.52	7.68	3.70	80.38	7.42	0.06	0.00	0.46	310.41
H04-0078	Na-HCO3	29.1170400	-23.6651300	7.98	94.70	713.06	48.28	29.28	78.28	64.38	35.09	146.82	14.84	9.97	0.00	0.19	286.75
H04-0084	Na-HCO3	29.1222100	-23.6331400	8.13	120.70	892.64	75.79	40.69	130.16	10.11	30.96	192.21	20.46	7.62	0.00	0.29	389.11
H04-0089	Mg-HCO3	29.2057300	-23.5086600	8.15	111.10	838.80	48.26	61.43	94.14	20.19	26.93	138.29	22.22	2.73	0.00	0.21	441.75
H04-0089A	Na-HCO3	29.0908600	-23.5800400	8.07	109.60	794.86	57.29	30.74	126.89	12.28	34.10	136.47	25.68	10.62	0.00	0.43	357.95
H04-0092	Na-HCO3	29.0881000	-23.5373000	8.20	62.40	469.03	29.30	16.20	71.90	12.26	6.23	67.38	9.61	1.21	0.00	0.10	256.16
H04-0099	Mg-HCO3	29.0980700	-23.4400700	8.21	102.10	776.86	48.96	49.29	91.52	18.91	33.21	125.77	16.23	4.15	0.00	0.18	406.94
H04-0100	Mg-HCO3	29.1112000	-23.4800600	8.18	106.20	798.25	51.84	50.58	84.05	20.37	33.28	144.77	19.29	3.63	0.00	0.20	410.95
H04-0104	Na-HCO3	29.1269000	-23.4446700	8.25	119.30	893.96	62.72	55.38	110.10	16.13	30.00	138.74	15.23	8.16	0.00	0.23	459.24
H04-0105A	Na-HCO3	29.1978300	-23.4845300	8.12	120.30	939.67	31.52	39.33	179.65	10.13	39.34	152.93	19.12	5.65	0.00	0.38	481.47
H04-0113A	Na-Cl	29.2599500	-23.4940500	8.26	110.00	632.00	53.50	37.00	108.00	10.70	38.20	168.80	24.10	9.28	41.10	0.20	270.30
H04-0113A	Na-HCO3	29.2608500	-23.4923100	8.25	109.10	767.01	54.03	35.98	115.62	12.05	38.37	153.95	19.81	10.46	0.00	0.32	328.92
H04-0116	Na-HCO3	29.1988300	-23.5331900	7.96	68.60	487.00	25.14	27.72	80.38	7.17	38.79	94.68	55.98	3.91	0.00	0.73	177.80
H04-0120	Mg-HCO3	29.1633400	-23.5043900	8.06	109.20	837.88	55.03	54.47	95.26	19.26	31.55	131.99	22.30	4.12	0.00	0.20	441.05
H04-0121	Na-HCO3	29.1237500	-23.5095000	8.53	97.70	953.71	73.29	58.97	114.42	11.97	25.56	140.57	34.18	7.97	0.00	0.25	484.71
H04-0122	Na-HCO3	29.1534300	-23.5364700	8.02	39.00	291.20	14.96	8.92	49.02	6.64	10.40	23.89	10.12	0.06	0.00	0.10	177.18
H04-0125	Na-HCO3	29.1947200	-23.5594300	8.11	69.50	512.26	35.13	24.61	78.93	5.64	37.30	86.47	11.62	6.80	0.00	0.43	239.09
H04-0129	Na-HCO3	29.2431690	-23.6255915	7.85	104.20	784.10	54.92	28.51	135.90	9.99	32.83	127.20	32.56	7.39	32.71	0.41	361.82
H04-0141	Mg-HCO3	29.2869000	-23.5466000	8.29	90.50	702.21	43.05	49.59	65.09	21.44	35.00	84.59	18.07	4.72	0.00	0.21	399.18
H04-0183	Na-HCO3	29.0902500	-23.5806600	8.16	107.40	824.03	49.78	29.34	143.18	12.50	35.18	147.00	31.66	12.36	0.00	0.46	355.25
H04-0189	Na-HCO3	29.3046982	-23.7654432	7.97	67.80	521.94	19.30	13.27	99.55	10.65	38.90	52.35	21.44	7.88	34.88	1.00	269.34
H04-0220	Na-HCO3	28.7082367	-23.2754479	7.55	72.40	500.03	28.98	21.14	86.95	4.22	39.05	80.52	15.48	3.48	15.41	0.78	246.44
H04-0222	Na-Cl	28.7954740	-23.3882958	8.08	263.00	1536.04	151.78	87.88	209.74	7.83	34.80	595.89	40.69	7.72	34.17	0.29	407.65
H04-0228	Na-HCO3	29.0540833	-23.3326941	8.36	199.00	1322.00	58.59	88.72	186.43	21.38	36.18	295.34	52.47	17.38	76.94	0.36	541.73
H04-0229	Na-Cl	28.9761900	-23.3761100	8.17	278.00	1521.55	94.93	99.60	272.53	32.96	10.44	711.80	88.61	4.43	0.00	0.10	201.34
H04-0229	Na-Cl	28.9761900	-23.3761100	8.17	278.00	1521.55	94.93	99.60	272.53	32.96	10.44	711.80	88.61	4.43	0.00	0.10	201.34
H04-0233	Na-Cl	29.0199805	-23.3929360	8.33	84.00	528.72	25.02	22.53	97.32	5.10	2.86	161.83	6.10	0.04	0.18	0.20	204.05
H04-0234	Na-HCO3	29.0200100	-23.3968100	8.14	111.10	832.07	53.71	44.20	109.47	18.69	23.88	154.37	17.49	2.19	0.00	0.23	424.02
H04-0236	Na-HCO3	29.0168504	-23.3956258	8.12	115.20	869.14	62.04	50.78	111.90	13.70	26.68	135.85	16.09	6.50	28.77	0.20	449.68
H04-0239	Na-HCO3	28.9844400	-23.4952800	8.31	121.60	926.25	61.43	40.07	148.84	14.25	33.30	183.46	33.02	10.24	0.00	0.49	399.07
H04-0241	Na-HCO3	28.9939600	-23.5235000	8.09	109.40	834.20	53.39	35.07	132.52	11.67	33.82	142.08	30.66	6.72	0.00	0.47	398.52
H04-0243	Na-HCO3	28.9861100	-23.5272100	8.49	105.50	798.61	50.45	35.89	118.30	22.57	34.51	139.48	25.18	7.19	0.00	0.41	374.06
H04-0252	Na-Cl	28.9399657	-23.5237923	8.44	228.00	1588.90	87.80	71.76	308.60	9.86	31.92	456.08	41.78	8.86	39.22	0.35	553.32
H04-0270	Na-HCO3	29.0101000	-23.6164597	8.01	167.00	1320.87	31.65	28.37	192.54	155.44	18.05	120.92	104.42	11.68	51.71	0.77	634.77
H04-0305	Na-Cl	28.9748985	-23.7161637	8.25	173.00	1034.38	78.35	45.19	172.15	4.95	36.28	264.42	22.35	11.50	50.90	2.33	393.69
H04-0306	Na-HCO3	28.9797986	-23.7161937	8.23	119.90	889.49	60.44	38.02	144.85	4.81	35.55	187.15	17.88	11.04	48.89	2.20	385.19
H04-0312	Na-HCO3	28.9324648	-23.7965514	7.79	114.80	860.81	65.67	38.42	118.21	6.18	34.84	129.96	21.67	11.67	51.66	0.85	428.10
H04-0313	Na-HCO3	28.9299647	-23.7998845	8.03	139.00	928.48	78.01	47.40	119.12	11.14	34.32	177.05	28.44	15.52	68.70	0.72	399.72
H04-0359	Na-Cl	29.2441670	-23.6025000	7.58	103.10	684.24	34.55	25.41	128.81	17.08	12.10	176.92	23.35	0.06	0.00	0.37	276.29
H04-0365	Na-HCO3	29.0574700	-23.6518300	8.03	118.20	909.40	56.53	34.57	160.72	9.29	35.79	140.09	21.41	8.73	0.00	0.61	447.39
H04-0373	Na-HCO3	29.0793900	-23.8312797	8.17	51.00	333.15	22.17	14.61	58.89	2.30	21.79	42.28	18.27	1.53	6.77	0.25	207.49
H04-0375	Na-HCO3	29.0688510	-23.8250364	8.32	76.50	610.65	42.60	27.64	81.96	6.28	30.51	57.63	9.83	5.39	23.86	0.27	360.19
H04-0402	Na-HCO3	29.1466670	-23.8766670	8.36	70.00	517.61	39.67	23.58	73.13	3.61	29.21	50.27	20.27	6.46	0.00	0.21	278.21
H04-0410	Na-HCO3	29.1738900	-23.9255600	8.57	95.00	796.00	62.15	29.94	119.40	1.66	25.23	85.29	22.24	12.68	0.00	1.67	417.43
H04-0411	Na-HCO3	29.1728900	-23.9268200	8.30	62.60	487.51	36.50	16.18	70.96	1.52	18.54	36.82	15.85	5.01	0.00	2.12	285.33

Borehole nr.	Water type	X	Y	pH	EC	TDS	Ca	Mg	Na	K	Si	Cl	SO4	N	NO3	F	HCO3
H04-0412	Na-HCO3	29.1691700	-23.9322200	8.38	55.20	425.03	28.33	12.05	76.89	2.53	12.41	52.88	26.27	2.30	0.00	1.03	214.79
H04-0413	Na-HCO3	29.1627500	-23.9373700	7.95	56.00	428.10	21.60	12.09	78.51	1.67	23.45	36.18	10.16	5.89	0.00	1.63	240.14
H04-0429	Na-HCO3	29.1366700	-23.9294400	8.61	54.10	396.50	27.62	9.82	68.40	0.68	18.85	5.00	23.18	5.05	0.00	2.22	237.12
H04-0456	Na-Cl	29.1061000	-23.6323900	8.19	116.00	892.61	52.56	39.76	151.66	13.19	33.17	223.18	20.27	4.36	0.00	0.43	372.19
H04-0487	Na-HCO3	29.1907444	-23.9043212	7.54	48.60	374.54	23.47	10.44	65.30	2.51	23.15	31.49	6.60	6.63	29.35	1.54	203.54
H04-0497	Na-HCO3	29.0769314	-23.7559811	8.18	67.50	520.13	26.40	19.03	86.54	4.05	34.56	34.64	14.01	7.54	33.39	1.27	300.75
H04-0505	Na-HCO3	29.1462339	-23.5381062	7.70	85.50	506.00	53.50	35.60	81.80	3.90	0.00	74.20	23.70	12.90	57.11	0.24	365.55
H04-0507	Na-HCO3	29.1637500	-23.4853300	8.71	98.10	767.15	47.89	46.02	98.38	16.68	35.83	119.75	20.42	4.60	0.00	0.22	397.33
H04-0511	Na-HCO3	29.2197200	-23.7886600	8.06	54.30	390.45	24.50	13.41	59.80	5.17	35.67	21.59	11.05	11.65	0.00	0.88	202.46
H04-0516	Na-HCO3	29.1722400	-23.5625200	8.81	109.70	909.57	30.73	23.21	198.24	15.97	39.55	153.49	35.26	15.45	0.00	0.76	383.46
H04-0552	Na-HCO3	29.0279106	-23.4809299	7.96	150.80	921.00	68.40	56.20	178.80	7.90	0.00	243.50	54.50	4.50	19.92	0.26	520.88
H04-0553	Na-HCO3	29.0462900	-23.4697100	8.40	92.60	716.46	49.52	39.43	92.35	11.68	33.04	112.48	18.00	8.14	0.00	0.22	356.60
H04-0561	Na-Cl	29.0319700	-23.4344700	8.26	150.00	981.09	51.67	48.76	175.08	9.97	37.43	238.10	38.37	6.48	0.00	0.36	390.02
H04-0561	Na-Cl	29.0319700	-23.4344700	8.26	150.00	981.09	51.67	48.76	175.08	9.97	37.43	238.10	38.37	6.48	0.00	0.36	390.02
H04-0573	Na-HCO3	29.1708330	-23.9277780	8.74	64.30	548.66	20.69	12.36	115.76	1.50	24.72	30.95	11.27	5.39	0.00	1.83	330.37
H04-0575	Na-Cl	28.9363545	-23.5235146	8.18	291.00	1979.25	125.04	110.54	345.12	12.89	29.62	730.28	59.61	5.34	23.64	0.27	571.73
H04-0577	Na-HCO3	29.1143800	-23.5970900	8.43	95.90	710.23	30.09	28.31	132.11	12.33	39.73	128.08	21.33	6.95	0.00	0.63	326.53
H04-0593	Na-HCO3	29.2852500	-23.6302500	8.76	97.40	820.18	55.63	36.97	122.28	8.96	35.16	120.91	33.99	7.27	0.00	0.62	408.53
H04-0593	Na-HCO3	29.2852500	-23.6302500	8.76	97.40	820.18	55.63	36.97	122.28	8.96	35.16	120.91	33.99	7.27	0.00	0.62	408.53
H04-0599	Na-HCO3	29.2236404	-23.7053360	7.90	75.90	546.33	33.33	23.83	74.38	5.94	33.44	62.36	12.75	14.67	64.94	0.30	267.17
H04-0644	Na-Cl	28.9772200	-23.5222100	7.87	230.00	1390.09	133.80	92.16	177.56	24.22	26.35	341.72	36.74	22.88	0.00	0.27	481.52
H04-0645	Na-HCO3	28.9919200	-23.5299800	8.21	72.60	647.65	49.76	23.44	77.13	12.79	44.85	7.64	6.34	4.45	0.00	0.87	449.67
H04-0646	Ca-HCO3	29.0218600	-23.5217500	8.22	58.80	463.64	52.27	19.01	34.95	21.82	38.89	28.67	17.35	4.77	0.00	0.22	268.04
H04-0650	Na-HCO3	29.3522300	-23.6475000	8.12	55.90	416.10	25.49	12.59	69.01	6.95	35.71	46.89	14.41	8.20	0.00	0.88	203.41
H04-0652	Na-HCO3	29.2250900	-23.3775600	8.48	95.80	830.23	53.19	28.02	139.58	12.09	34.62	103.34	38.44	2.32	0.00	0.61	444.65
H04-0655	Na-HCO3	29.2513600	-23.6171900	7.85	154.00	1031.64	50.37	31.86	223.70	17.20	39.44	233.24	45.71	5.80	0.00	0.70	402.51
H04-0660	Na-HCO3	29.1606900	-23.6512400	8.30	110.70	893.21	51.66	33.63	145.48	11.06	37.25	136.65	20.47	6.50	0.00	0.60	464.78
H04-0660	Na-HCO3	29.1606900	-23.6512400	8.30	110.70	893.21	51.66	33.63	145.48	11.06	37.25	136.65	20.47	6.50	0.00	0.60	464.78
H04-0665	Na-Cl	28.9414400	-23.5235500	8.16	199.00	1194.00	72.50	62.80	256.00	8.50	35.20	405.90	43.60	6.82	30.20	0.40	420.80
H04-0665	Na-Cl	28.9413546	-23.5235146	8.65	218.00	1455.19	77.37	65.23	277.38	9.10	33.55	440.32	37.04	8.65	38.29	0.34	509.91
H04-0666	Mg-Cl	28.7435726	-23.2682540	5.78	12.40	120.00	6.60	8.90	16.10	0.80	0.00	29.00	15.50	0.80	3.54	0.05	35.12
H04-0672	Na-HCO3	28.7951110	-23.4154163	8.49	204.00	1373.88	45.58	46.55	308.90	1.88	39.90	272.55	95.00	29.02	128.47	0.72	474.14
H04-0679	Na-HCO3	29.1817000	-23.7080300	8.18	70.90	534.92	32.15	21.34	85.45	6.19	33.04	61.44	9.24	4.42	0.00	0.35	299.17
H04-0679	Na-HCO3	29.1817000	-23.7080300	8.18	70.90	534.92	32.15	21.34	85.45	6.19	33.04	61.44	9.24	4.42	0.00	0.35	299.17
H04-0682	Na-HCO3	29.1566670	-23.6252780	8.09	92.80	752.34	36.07	23.15	136.50	8.06	39.68	80.79	18.44	6.15	0.00	0.92	421.17
H04-0682	Na-HCO3	29.1566670	-23.6252780	8.09	92.80	752.34	36.07	23.15	136.50	8.06	39.68	80.79	18.44	6.15	0.00	0.92	421.17
H04-0684	Na-Cl	29.1988500	-23.6072500	8.27	110.00	740.63	55.24	24.15	126.62	7.93	36.40	171.20	62.90	5.05	0.00	0.48	269.45
H04-0747	Na-HCO3	29.0163598	-23.6679467	7.08	128.90	773.00	82.30	46.30	131.90	7.40	0.00	131.30	36.99	21.00	92.96	0.85	390.79
H04-0765	Na-HCO3	29.2213300	-23.4388000	8.34	100.70	789.40	51.29	39.27	110.85	11.15	36.14	122.78	23.57	17.02	0.00	0.28	354.67
H04-0773	Mg-HCO3	29.1331600	-23.4512700	8.46	104.70	826.01	54.88	55.27	88.50	20.28	32.01	133.91	19.72	12.76	0.00	0.21	396.54
H04-0779	Na-HCO3	29.1113900	-23.6141700	8.18	102.90	765.46	55.85	33.16	112.23	13.25	37.51	145.11	11.98	4.99	0.00	0.47	371.26
H04-0787	Ca-HCO3	28.9291666	-23.3417497	8.24	154.00	1042.67	117.33	52.36	113.56	1.27	27.17	210.33	14.12	19.68	87.12	0.22	446.25
H04-0790	Mg-HCO3	28.9124074	-23.4005652	8.16	116.90	811.12	73.88	62.37	72.20	4.26	39.63	153.05	17.23	9.41	41.66	0.74	385.65
H04-0792	Na-HCO3	29.0172905	-23.3971657	8.22	106.20	816.34	52.69	41.58	106.20	17.37	22.38	129.84	22.32	0.13	0.58	0.19	445.47
H04-0817	Na-Cl	28.7180520	-23.2713838	8.19	199.00	1048.26	91.08	59.69	171.52	3.37	10.00	472.91	16.37	5.79	25.63	0.35	207.27

Borehole nr.	Water type	X	Y	pH	EC	TDS	Ca	Mg	Na	K	Si	Cl	SO4	N	NO3	F	HCO3
H04-0820	Mg-HCO3	28.6875110	-23.3230901	8.21	173.00	1117.12	121.58	81.68	74.49	0.87	38.21	173.93	4.00	74.54	329.97	0.24	332.26
H04-0822	Na-HCO3	29.0211600	-23.5272400	8.64	99.70	835.83	52.24	36.56	132.81	11.97	30.97	156.24	31.13	8.49	0.00	0.33	376.91
H04-0835	Na-HCO3	29.1180600	-23.6600000	8.26	97.50	703.54	39.11	23.89	132.98	8.69	31.98	144.51	13.13	6.51	0.00	0.47	311.88
H04-0841	Na-HCO3	29.1847900	-23.7093500	7.90	69.30	552.99	19.93	14.61	114.81	4.72	34.40	77.29	15.26	3.24	0.00	0.31	291.57
H04-0842	Na-HCO3	29.1793600	-23.7296200	7.75	64.90	560.89	37.43	22.25	80.36	6.74	27.41	49.78	19.42	0.06	0.00	0.26	344.24
H04-0846	Na-HCO3	29.2383200	-23.6826200	8.19	72.30	603.85	32.79	23.80	95.61	6.59	34.33	51.19	10.29	4.49	0.00	0.39	363.26
H04-0853	Na-HCO3	29.2258905	-23.7070026	7.58	72.60	487.74	33.58	24.19	61.17	5.44	36.45	57.78	10.62	23.24	102.88	0.36	191.60
H04-0858	Na-HCO3	29.2608000	-23.7926500	8.18	76.20	569.82	38.16	21.11	92.43	8.34	31.88	69.69	15.90	5.21	0.00	0.36	300.67
H04-0859	Na-HCO3	29.2503800	-23.8062700	8.09	73.10	515.68	27.71	20.11	84.70	8.63	31.87	90.30	13.72	12.79	0.00	0.27	213.53
H04-0864	Na-HCO3	29.3062900	-23.6893100	8.04	71.30	522.78	22.78	16.15	109.41	4.03	39.59	85.14	32.70	13.93	0.00	1.06	189.78
H04-0882	Na-HCO3	28.9377434	-23.5190704	8.35	112.50	914.01	68.78	34.33	112.65	39.37	26.42	110.16	17.96	10.31	45.64	0.17	483.57
H04-0910	Na-HCO3	29.0803700	-23.6679200	8.40	150.00	940.00	57.30	50.00	192.00	11.70	41.50	216.60	29.90	5.62	24.90	0.70	425.40
H04-0910	Na-HCO3	29.0803700	-23.6679200	8.40	150.00	940.00	57.30	50.00	192.00	11.70	41.50	216.60	29.90	5.62	24.90	0.70	425.40
H04-0924	Na-HCO3	29.0832721	-23.5267269	8.11	105.40	628.00	62.40	28.60	121.50	6.90	0.00	130.10	36.60	8.50	37.63	0.29	365.06
H04-0930	Mg-HCO3	29.2111300	-23.5157200	8.31	87.30	686.02	45.06	43.74	82.25	8.14	30.37	77.12	11.24	3.75	0.00	0.19	401.59
H04-0943	Na-HCO3	29.2001900	-23.4573800	8.09	96.10	730.42	43.28	30.27	118.39	11.44	36.00	97.58	19.54	7.10	0.00	0.45	377.91
H04-0947	Na-HCO3	28.9662085	-23.5833627	8.51	169.00	1198.68	33.38	32.52	237.78	9.43	39.33	174.42	52.36	6.22	27.52	2.15	629.04
H04-0949	Na-HCO3	28.9940792	-23.6329494	8.48	104.00	833.73	7.46	7.97	191.67	3.90	36.39	55.90	31.31	3.76	16.66	4.07	514.67
H04-0949	Na-HCO3	28.9940792	-23.6329494	8.48	104.00	833.73	7.46	7.97	191.67	3.90	36.39	55.90	31.31	3.76	16.66	4.07	514.67
H04-0958	Na-Cl	28.9452875	-23.7676601	7.94	477.00	2840.73	213.98	145.12	525.09	13.67	39.33	1293.13	143.36	8.42	37.26	2.90	466.17
H04-0958	Na-Cl	28.9452875	-23.7676601	7.94	477.00	2840.73	213.98	145.12	525.09	13.67	39.33	1293.13	143.36	8.42	37.26	2.90	466.17
H04-0961	Na-HCO3	29.2488600	-23.8223800	8.08	53.40	373.13	22.56	15.45	51.55	11.89	32.76	38.55	8.43	10.09	0.00	0.22	179.59
H04-0964	Na-HCO3	29.2112400	-23.8232000	8.18	70.20	496.47	34.50	19.26	73.60	6.58	28.63	69.30	11.51	6.59	0.00	0.35	251.81
H04-0969	Mg-HCO3	29.2166670	-23.8666670	8.12	60.90	462.78	37.72	24.94	46.03	2.03	25.47	28.54	7.51	11.04	0.00	0.25	266.81
H04-0969	Mg-HCO3	29.2166670	-23.8666670	8.12	60.90	462.78	37.72	24.94	46.03	2.03	25.47	28.54	7.51	11.04	0.00	0.25	266.81
H04-0975	Na-HCO3	29.2503000	-23.5879600	8.25	87.70	710.25	51.41	29.07	107.41	13.98	33.80	90.51	22.89	7.25	0.00	0.40	362.36
H04-0978	Na-HCO3	29.0772300	-23.7828000	8.12	60.30	488.41	23.53	17.91	86.35	3.78	35.88	34.03	8.70	3.28	0.00	0.44	299.07
H04-0989	Na-HCO3	29.0484720	-23.8151937	8.02	67.90	510.50	28.75	27.40	65.24	6.12	33.40	46.23	7.93	6.02	26.66	0.38	301.73
H04-0989	Na-HCO3	29.0484720	-23.8151937	8.02	67.90	510.50	28.75	27.40	65.24	6.12	33.40	46.23	7.93	6.02	26.66	0.38	301.73
H04-1003	Na-HCO3	29.1369900	-23.6170600	7.60	101.10	787.45	51.01	28.46	109.32	41.42	39.54	161.14	29.66	7.19	0.00	0.27	334.29
H04-1049	Na-HCO3	29.0513305	-23.8161770	8.14	21.50	131.86	13.63	4.92	21.21	0.75	8.66	10.00	8.95	0.04	0.18	0.36	116.35
H04-1054	Na-Cl	28.9166273	-23.4860993	8.18	226.00	1425.73	87.75	83.71	212.98	18.54	30.22	400.72	61.10	0.79	3.50	0.24	557.10
H04-1054	Na-Cl	28.9166273	-23.4860993	8.18	226.00	1425.73	87.75	83.71	212.98	18.54	30.22	400.72	61.10	0.79	3.50	0.24	557.10
H04-1057	Na-HCO3	29.2038058	-23.4482825	8.17	78.40	632.17	32.36	23.00	98.77	11.19	38.07	68.88	15.54	11.97	52.99	0.38	328.98
H04-1107	Na-HCO3	29.2319460	-23.7241436	7.94	68.00	481.66	29.50	19.91	65.59	6.92	33.03	48.97	14.13	9.19	40.68	0.57	255.24
H04-1109	Na-HCO3	29.2313628	-23.7303621	7.70	61.30	464.75	24.08	19.44	62.86	8.17	34.22	29.06	12.61	5.54	24.52	0.31	283.49
H04-1121	Na-HCO3	29.1647200	-23.6868800	8.43	108.40	820.28	50.09	35.08	130.04	11.54	29.69	145.33	26.63	13.43	0.00	0.30	361.72
H04-1302	Na-HCO3	29.2339900	-23.5200800	8.38	80.20	640.60	45.38	32.85	71.98	24.26	35.12	90.83	11.32	7.04	0.00	0.24	332.43
H04-1381	Ca-HCO3	28.8044400	-23.3772500	8.12	39.30	268.54	27.19	14.83	23.09	1.15	53.15	34.21	5.57	0.76	0.00	0.38	158.69
H04-1392	Na-Cl	28.9802780	-23.4008330	8.21	175.00	989.84	41.30	67.57	159.50	15.32	35.14	304.03	29.64	8.28	0.00	0.20	335.57
H04-1392	Na-HCO3	28.9804440	-23.4008608	7.88	163.00	992.90	67.70	51.18	160.62	10.59	32.23	220.66	30.16	9.85	43.60	0.22	408.10
H04-1393	Mg-Cl	28.8776464	-23.3927857	7.58	191.00	1037.65	107.89	74.49	123.53	1.44	20.51	431.88	4.08	10.92	48.34	0.18	245.04
H04-1466	Mg-HCO3	28.9862800	-23.4414400	8.39	72.30	577.15	47.97	31.24	54.55	11.09	28.51	32.57	7.05	2.28	0.00	0.22	382.29
H04-1472	Na-HCO3	28.9076100	-23.4402000	8.19	152.00	928.00	78.50	55.60	167.00	15.10	41.30	233.60	52.00	10.57	46.80	0.40	423.80
H04-1473	Na-Cl	28.8765400	-23.4211200	8.43	200.00	1380.00	46.10	70.10	262.00	30.00	45.10	390.00	66.20	25.55	113.10	0.40	423.40

Borehole nr.	Water type	X	Y	pH	EC	TDS	Ca	Mg	Na	K	Si	Cl	SO4	N	NO3	F	HCO3
H04-1478	Mg-Cl	28.9394400	-23.4177780	8.18	269.00	1644.28	114.21	127.81	219.77	11.10	38.62	537.78	63.42	13.48	0.00	0.27	510.16
H04-1486	Na-HCO3	28.9389400	-23.4176400	8.27	46.40	386.12	21.82	10.57	67.66	1.19	16.87	15.91	13.16	0.15	0.00	0.56	254.54
H04-1487	Na-HCO3	28.9383300	-23.4422220	8.15	178.00	1179.31	88.21	56.46	164.52	16.69	37.13	236.33	44.20	15.03	0.00	0.39	505.77
H04-1488	Na-HCO3	28.9463900	-23.4600000	8.33	166.00	1106.99	81.42	54.89	151.88	15.16	35.85	207.60	35.72	17.69	0.00	0.34	481.42
H04-1489	Mg-HCO3	28.9097200	-23.4033330	8.23	117.80	913.39	72.31	69.09	94.96	5.79	43.16	187.30	17.09	19.15	0.00	0.74	381.18
H04-1489 (H0	Mg-Cl	28.9110700	-23.4020400	8.28	156.00	1078.00	92.30	87.20	109.00	6.60	48.00	276.40	26.20	13.03	57.70	0.60	400.80
H04-1504	Na-HCO3	29.1212800	-23.6502100	8.03	91.60	686.56	48.95	30.42	105.87	10.91	36.15	157.92	13.79	6.44	0.00	0.25	289.84
H04-1517	Ca-HCO3	29.1343300	-23.9306100	8.02	58.00	408.58	42.88	14.43	43.66	0.89	14.35	43.31	6.38	8.96	0.00	2.40	214.65
H04-1518	Na-HCO3	29.1555140	-23.6126911	8.33	113.70	842.33	44.95	27.49	159.43	5.63	39.15	131.99	29.11	8.50	37.63	0.51	405.38
H04-1540	Na-HCO3	29.2441300	-23.6962200	7.91	35.50	246.13	14.59	14.84	32.12	4.15	26.91	29.80	30.54	8.45	0.00	0.20	82.24
H04-1543	Mg-HCO3	29.2415800	-23.6927000	8.38	156.00	1078.67	35.43	126.12	59.24	7.48	29.36	154.67	96.78	50.66	0.00	0.45	373.78
H04-1544	Na-HCO3	29.2252700	-23.7118500	7.78	67.80	506.68	29.95	26.03	71.94	8.25	35.79	71.28	22.31	13.28	0.00	0.28	217.70
H04-1545	Na-HCO3	29.2999700	-23.6048600	8.51	83.70	593.33	41.74	23.06	85.58	8.36	37.66	70.55	33.79	13.42	0.00	0.53	270.23
H04-1566	Na-HCO3	29.0839200	-23.8677200	8.01	65.00	356.00	33.80	19.10	73.20	4.70	28.60	41.20	6.60	4.36	19.30	0.50	245.00
H04-1591	Na-HCO3	28.8793900	-23.3873500	8.13	117.30	910.01	69.27	39.36	118.89	27.52	31.22	194.72	34.09	6.62	0.00	0.27	396.00
H04-1592	Na-HCO3	28.8825000	-23.4511600	8.35	84.30	752.77	62.15	37.23	79.16	9.42	3.24	24.63	21.10	21.71	0.00	0.30	421.92
H04-1604	Na-HCO3	29.0462800	-23.8404300	8.12	56.00	460.08	30.94	21.69	54.35	8.33	24.67	34.98	5.16	7.09	0.00	0.27	272.92
H04-1608	Na-Cl	29.0348400	-23.8069300	7.65	523.00	3198.68	221.69	125.79	696.67	3.54	29.89	1425.14	47.77	38.81	0.00	1.88	504.18
H04-1623	Na-HCO3	29.0064300	-23.4838200	8.66	91.50	729.58	46.58	18.80	122.99	3.62	33.28	69.69	11.23	8.73	0.00	1.76	416.16
H04-1623	Na-HCO3	29.0064300	-23.4838200	8.66	91.50	729.58	46.58	18.80	122.99	3.62	33.28	69.69	11.23	8.73	0.00	1.76	416.16
H04-1633	Na-Cl	29.1854500	-23.6330600	8.13	100.80	706.19	54.77	31.47	101.38	12.84	39.22	153.69	32.68	13.23	0.00	0.40	260.19
H04-1641	Mg-HCO3	28.9425400	-23.3908900	8.05	176.00	1136.87	89.96	82.15	96.72	22.71	40.13	239.79	24.13	23.43	0.00	0.34	477.27
H04-1643	Ca-HCO3	29.2075000	-23.4372220	8.34	32.50	261.02	28.80	14.79	8.90	14.00	17.26	5.76	2.00	2.59	0.00	0.49	174.71
H04-1644	Na-HCO3	29.2175000	-23.4469440	8.16	68.10	491.58	24.09	26.72	73.14	7.59	39.90	85.36	14.18	16.63	0.00	0.43	186.32
H04-1649	Mg-HCO3	29.0326200	-23.4450900	8.06	91.90	774.32	42.76	72.04	56.95	14.04	45.02	105.68	18.22	2.67	0.00	0.17	452.58
H04-1650	Na-HCO3	29.1331600	-23.4740500	8.20	102.60	776.28	43.36	46.47	106.14	13.81	30.32	124.96	22.06	4.69	0.00	0.23	398.36
H04-1650	Na-HCO3	29.1331600	-23.4740500	8.20	102.60	776.28	43.36	46.47	106.14	13.81	30.32	124.96	22.06	4.69	0.00	0.23	398.36
H04-1651	Na-HCO3	29.2567700	-23.5083200	8.21	96.30	676.22	60.21	34.85	76.66	10.92	37.14	107.92	33.57	18.85	0.00	0.25	268.17
H04-1658	Na-HCO3	29.1477600	-23.5507500	8.13	85.20	707.50	45.06	28.58	106.78	13.70	36.83	83.76	16.85	8.10	0.00	0.71	376.13
H04-1663	Na-HCO3	29.0861100	-23.8564500	8.08	61.70	535.96	23.44	12.48	111.05	1.94	31.05	30.35	13.64	2.08	0.00	0.59	333.14
H04-1666	Na-HCO3	29.2735100	-23.8110000	8.14	61.80	476.23	32.60	14.71	64.51	22.03	32.22	56.30	19.01	3.36	0.00	0.22	251.61
H04-1670	Na-HCO3	29.2478300	-23.5960500	7.99	96.70	734.41	49.49	29.65	116.68	16.28	37.81	129.95	27.38	20.64	0.00	0.30	273.06
H04-1672	Na-HCO3	29.2524200	-23.6059700	8.41	90.90	637.42	37.02	19.91	100.16	22.06	33.60	133.41	43.24	5.43	0.00	0.34	257.09
H04-1675	Na-Cl	29.1959100	-23.6449100	7.50	113.20	819.30	56.05	29.41	151.05	3.38	26.66	230.51	24.59	15.12	0.00	0.32	256.62
H04-1685	Na-HCO3	29.3289900	-23.6505800	8.13	74.00	620.68	47.21	23.42	85.13	6.77	34.53	41.08	15.92	14.26	0.00	0.66	337.29
H04-1689	Na-HCO3	29.3252200	-23.6575500	8.01	72.20	535.23	38.74	23.12	65.13	12.05	38.59	44.83	35.72	17.93	0.00	0.68	235.47
H04-1692	Na-HCO3	29.3156500	-23.7142000	7.73	42.10	293.06	20.15	11.44	42.28	1.76	39.00	29.17	9.85	10.09	0.00	0.66	132.94
H04-1726	Na-Cl	29.1624100	-23.4177800	8.89	436.00	2880.58	41.13	220.44	542.78	31.84	27.81	1166.15	39.67	7.02	0.00	0.65	806.08
H04-1726	Na-Cl	29.1624100	-23.4177800	8.89	436.00	2880.58	41.13	220.44	542.78	31.84	27.81	1166.15	39.67	7.02	0.00	0.65	806.08
H04-1776	Ca-HCO3	29.0587742	-23.7419443	8.08	77.40	566.83	54.42	32.49	50.58	4.33	25.09	48.51	24.96	15.51	68.68	1.74	280.83
H04-1776	Ca-HCO3	29.0587742	-23.7419443	8.08	77.40	566.83	54.42	32.49	50.58	4.33	25.09	48.51	24.96	15.51	68.68	1.74	280.83
H04-1825	Na-Cl	29.1955800	-23.6456900	7.91	152.00	918.38	66.69	43.03	157.39	4.98	25.94	293.18	26.17	6.09	0.00	0.40	297.70
H04-1840	Na-HCO3	29.2900300	-23.5855300	8.11	80.00	660.99	38.99	21.42	102.00	10.55	38.30	85.01	71.76	5.03	0.00	0.38	308.58
H04-1949	Mg-Cl	29.0541100	-23.3326500	8.26	233.00	1447.37	84.36	111.18	187.10	21.22	39.60	345.41	54.30	21.36	0.00	0.39	548.69
H04-1950	Na-HCO3	29.0695100	-23.3950400	7.99	103.30	784.41	44.47	37.82	112.54	20.62	15.60	115.43	26.18	0.06	0.00	0.23	426.84

Borehole nr.	Water type	X	Y	pH	EC	TDS	Ca	Mg	Na	K	Si	Cl	SO4	N	NO3	F	HCO3
H04-1951	Na-HCO3	29.0999500	-23.4694600	8.27	74.10	536.79	13.23	34.22	85.12	7.48	1.52	89.02	8.92	0.06	0.00	0.10	298.05
H04-1952	Na-HCO3	29.0388600	-23.4437600	8.49	91.00	650.80	13.09	43.82	105.28	14.08	3.58	125.32	17.22	0.13	0.00	0.22	330.63
H04-1955	Na-HCO3	29.0201700	-23.3969300	8.22	112.00	832.49	54.26	43.33	110.17	18.91	24.25	150.01	18.03	2.63	0.00	0.29	425.72
H04-1962	Na-HCO3	29.1529800	-23.6314300	8.21	87.20	662.25	53.59	30.98	74.79	7.88	7.24	85.15	31.29	4.99	0.00	0.31	350.91
H04-1966	Na-HCO3	29.1057500	-23.3985000	8.12	147.00	969.88	48.28	48.79	167.60	17.07	14.59	216.07	28.03	8.67	0.00	0.35	404.62
H04-1969	Na-HCO3	29.0714600	-23.0000000	8.42	96.30	934.17	77.03	37.71	124.79	28.22	31.16	218.47	26.33	7.28	0.00	0.38	388.92
H04-1970	Na-HCO3	28.9831600	-23.4950000	7.71	139.00	975.13	49.05	38.28	173.49	12.96	26.02	180.77	34.20	5.25	0.00	0.62	462.46
H04-2118	Na-HCO3	28.9526182	-23.5613942	8.31	144.00	1102.95	28.70	30.71	239.63	8.79	36.71	152.91	39.97	7.07	31.31	1.48	569.41
H04-2146	Na-HCO3	29.0876921	-23.5647643	8.22	111.10	858.64	53.72	33.34	137.63	17.25	33.39	144.21	23.93	9.57	42.36	0.46	405.69
H04-2149	Na-Cl	29.2480600	-23.6202400	8.44	197.00	1227.55	50.64	30.37	286.73	17.83	23.34	298.03	72.96	3.29	0.00	0.68	455.66
H04-2152	Na-HCO3	29.2235900	-23.6083600	8.36	97.00	727.45	46.56	26.25	117.16	17.87	28.18	115.25	18.25	5.72	0.00	0.26	360.49
H04-2177	Na-HCO3	29.2555000	-23.6259100	7.83	79.90	571.62	29.73	21.42	105.31	6.28	38.34	91.04	22.65	7.81	0.00	0.40	260.19
H04-2178	Na-HCO3	29.2558000	-23.6277200	8.41	77.10	526.60	29.21	21.06	97.26	6.95	37.21	90.35	19.20	3.99	0.00	0.37	244.45
H04-2181	Na-HCO3	29.2876400	-23.5487900	7.90	88.60	669.28	47.33	38.25	79.34	12.90	36.27	87.80	15.92	9.27	0.00	0.30	346.33
H04-2184	Na-HCO3	29.2987200	-23.5407500	8.04	91.00	690.28	47.68	37.73	89.89	10.22	33.64	85.66	20.88	6.68	0.00	0.26	368.29
H04-2201	Na-HCO3	29.2050500	-23.5092400	8.12	104.40	792.47	51.96	45.47	107.97	13.69	35.86	131.29	14.79	6.24	0.00	0.25	399.24
H04-2205	Na-HCO3	28.9824100	-23.4048300	8.03	152.00	1045.13	67.19	63.01	143.85	12.38	30.53	210.20	25.04	9.38	0.00	0.25	481.56
H04-2226	Na-Cl	29.0371600	-23.3386100	8.28	534.00	3305.74	93.91	195.44	773.50	21.72	44.05	1418.79	176.86	0.61	0.00	0.91	621.84
H04-2226	Na-Cl	29.0371600	-23.3386100	8.28	534.00	3305.74	93.91	195.44	773.50	21.72	44.05	1418.79	176.86	0.61	0.00	0.91	621.84
H04-2228	Na-HCO3	29.1099100	-23.6353800	8.10	111.60	823.41	52.30	35.34	141.08	14.22	36.38	163.97	14.37	6.29	0.00	0.42	373.82
H04-2231	Na-Cl	28.9812700	-23.4424700	8.43	113.70	827.43	15.18	56.95	161.28	11.82	28.23	212.42	35.69	9.15	0.00	0.22	293.27
H11-0002	Mg-HCO3	29.2164200	-23.3034500	7.79	107.20	822.28	39.01	67.92	89.35	11.80	39.64	122.61	25.87	5.14	0.00	0.18	442.73
H11-0049	Ca-Cl	28.8839670	-23.2061186	8.02	400.00	2226.83	318.47	155.28	204.34	2.49	36.02	1012.84	44.66	31.15	137.89	0.28	350.51
H11-0060	Na-HCO3	29.0132010	-23.1305641	8.34	216.00	1421.32	69.16	73.78	235.27	12.90	39.35	310.13	80.81	12.28	54.36	0.50	584.29
H11-0070	Mg-HCO3	28.9675296	-23.1320539	7.96	58.90	440.41	45.09	28.02	29.57	0.78	25.22	25.03	6.18	8.61	38.11	0.21	267.31
H11-0076	Mg-HCO3	28.9284184	-23.1469128	8.58	119.50	916.72	94.14	73.10	52.56	0.43	25.69	159.54	6.88	0.11	0.49	0.21	529.30
H11-0095	Na-Cl	28.8238519	-23.1851211	6.41	28.20	142.35	9.45	8.67	16.59	4.89	12.50	36.26	4.00	13.06	57.83	0.10	6.57
H11-0103	Na-HCO3	28.8260742	-23.1852600	7.61	22.80	139.01	5.85	2.60	27.95	1.63	1.82	26.74	4.00	0.42	1.87	0.32	70.66
H11-0128	Mg-HCO3	28.6999616	-23.1520810	7.92	228.00	1608.82	124.63	144.99	102.52	1.67	39.24	221.96	53.20	108.31	479.47	0.58	479.70
H11-0138	Mg-NO3	28.7988547	-23.0827070	8.12	286.00	1922.24	151.49	178.25	130.22	3.28	38.70	291.27	109.71	147.62	653.48	0.75	403.66
H11-0139	Mg-HCO3	28.8066249	-23.1035456	8.03	87.30	699.32	71.29	45.56	50.30	0.67	33.37	32.37	10.35	12.19	53.96	0.46	434.25
H11-0141	Ca-HCO3	28.7069041	-23.0238259	8.14	86.30	682.26	77.69	40.21	51.53	1.05	37.54	36.54	10.65	23.62	104.56	0.34	369.61
H11-0146	Ca-HCO3	28.7027420	-23.0113318	8.08	96.60	739.57	81.82	43.28	47.87	2.18	38.74	45.89	22.34	39.61	175.35	0.31	319.14
H11-0152	Na-Cl	29.0603923	-23.1314542	8.08	230.00	1475.73	56.47	85.10	289.23	1.32	33.29	425.15	85.49	1.04	4.60	0.59	527.71
H11-0223	Mg-HCO3	28.9896905	-23.0349407	7.58	90.00	698.04	67.66	59.02	32.94	2.38	16.61	55.70	45.26	0.02	0.09	0.14	434.79
H11-0560	Na-HCO3	29.1029032	-23.3049022	8.38	157.00	1088.28	50.92	60.44	167.05	17.82	36.98	182.98	38.20	13.29	58.83	0.43	511.52
H11-0606	Na-HCO3	29.0955731	-23.2520459	8.44	178.00	1246.51	49.47	75.31	200.04	18.43	38.90	248.39	49.84	4.83	21.38	0.33	583.19
H11-0606	Na-HCO3	29.0955731	-23.2520459	8.44	178.00	1246.51	49.47	75.31	200.04	18.43	38.90	248.39	49.84	4.83	21.38	0.33	583.19
H11-0630	Na-HCO3	29.0814529	-23.1666418	7.82	230.00	1523.97	36.80	78.68	293.60	25.41	43.74	186.67	156.49	6.81	30.15	0.40	715.73
H11-0642	Ca-Cl	28.9390885	-23.2486558	7.55	178.00	991.94	170.44	47.32	72.05	2.16	22.07	336.78	13.22	22.18	98.19	0.20	251.51
H11-0653	Mg-HCO3	28.7121822	-23.0635482	8.11	147.00	1079.70	92.30	75.30	79.88	7.14	39.79	93.05	33.00	52.42	232.05	0.79	466.08
H11-0657	Na-Cl	28.7133761	-23.2215350	7.78	230.00	1394.38	110.58	87.49	221.25	3.99	44.30	491.82	135.80	3.09	13.68	0.34	329.36
H11-0664	Na-Cl	28.7381427	-23.2105980	7.69	945.00	5642.83	358.77	364.94	1092.91	42.71	45.01	2867.21	168.32	4.82	21.34	0.59	725.97
H11-0672	Na-HCO3	29.0761326	-23.2264876	8.43	150.00	1114.14	35.70	62.69	173.09	20.53	39.85	121.65	42.93	4.67	20.67	0.68	635.99
H11-0698	Na-HCO3	29.1161000	-23.4114400	7.93	138.00	929.26	59.60	47.54	143.87	11.54	30.87	155.34	39.93	12.45	0.00	0.37	415.26

Borehole nr.	Water type	X	Y	pH	EC	TDS	Ca	Mg	Na	K	Si	Cl	SO4	N	NO3	F	HCO3
H11-0703	Na-Cl	28.9731063	-23.1937041	7.68	746.00	4693.06	393.07	342.57	747.17	3.11	35.34	2277.55	167.97	52.85	233.96	0.30	527.23
H11-0731	Mg-Cl	28.7125150	-23.2233126	7.80	276.00	1539.79	146.10	118.52	171.28	2.78	43.53	575.39	79.15	15.76	69.77	0.32	376.40
H11-0735	Na-HCO3	28.7577833	-23.1960191	8.07	277.00	1920.12	31.45	33.74	522.82	12.35	39.85	405.33	101.36	14.91	66.00	1.22	745.72
H11-0737	Na-HCO3	29.2191406	-23.3207513	8.20	120.10	892.00	57.00	59.00	115.00	0.00	36.30	171.00	40.00	2.20	9.74	0.20	426.76
H11-0744	Mg-HCO3	28.8085750	-23.1021557	8.08	104.20	817.08	83.74	57.14	56.51	1.22	34.35	72.65	13.86	18.94	83.84	0.54	447.48
H11-0753	Mg-Cl	28.8113550	-23.1168747	7.76	327.00	2043.89	174.87	152.18	246.05	1.84	33.87	733.94	95.06	19.60	86.77	0.34	552.83
H11-0797	Mg-HCO3	29.2499674	-23.3402601	4.25	126.40	746.00	70.50	53.50	97.50	18.40	0.00	158.10	33.30	9.20	40.73	0.30	451.63
H11-0799	Mg-HCO3	29.2598577	-23.3309407	7.24	121.30	746.00	70.20	60.20	94.50	15.50	0.00	149.40	38.80	7.40	32.76	0.36	482.84
H11-0800	Mg-HCO3	29.2658879	-23.3298208	7.24	113.50	678.00	67.80	53.20	90.60	12.50	0.00	119.50	23.20	2.30	10.18	0.43	501.13
H11-0811	Na-HCO3	29.2249000	-23.3227800	8.20	145.00	945.47	66.59	60.37	116.11	15.62	35.19	204.45	48.71	6.56	0.00	0.22	404.27
H11-0811	Na-HCO3	29.2249000	-23.3227800	8.20	145.00	945.47	66.59	60.37	116.11	15.62	35.19	204.45	48.71	6.56	0.00	0.22	404.27
H11-0812	Na-HCO3	29.2224767	-23.3226912	8.20	123.70	889.00	58.00	59.00	116.00	12.20	36.80	178.00	42.00	2.70	11.95	0.20	412.12
H11-0812	Na-HCO3	29.2224767	-23.3226912	8.20	123.70	889.00	58.00	59.00	116.00	12.20	36.80	178.00	42.00	2.70	11.95	0.20	412.12
H11-0813	Mg-HCO3	29.2219167	-23.3204714	8.10	116.20	873.00	51.00	60.00	113.00	12.50	39.20	153.00	31.00	2.70	11.95	0.30	438.95
H11-0817	Na-Cl	29.1888890	-23.3463890	8.25	249.00	1735.99	145.73	119.42	228.70	13.85	29.09	571.47	45.76	44.16	0.00	0.36	415.13
H11-0817	Na-Cl	29.1888890	-23.3463890	8.25	249.00	1735.99	145.73	119.42	228.70	13.85	29.09	571.47	45.76	44.16	0.00	0.36	415.13
H11-0817A	Mg-Cl	29.3468200	-23.1894800	8.20	261.00	1646.70	133.74	108.25	194.86	12.51	28.60	551.74	47.03	39.13	0.00	0.28	424.91
H11-0818	Na-HCO3	29.1643900	-23.3473100	8.24	122.00	764.00	45.60	38.10	146.00	11.10	38.40	123.90	19.00	13.08	57.90	0.40	432.40
H11-0818	Na-HCO3	29.1638649	-23.3479693	8.10	123.50	1002.00	50.00	41.00	169.00	12.30	34.60	117.00	22.00	15.50	68.62	0.50	523.08
H11-0818	Na-HCO3	29.1643900	-23.3473100	8.24	122.00	764.00	45.60	38.10	146.00	11.10	38.40	123.90	19.00	13.08	57.90	0.40	432.40
H11-0820	Na-HCO3	29.1419143	-23.3354702	8.30	116.00	910.00	48.00	47.00	138.00	13.50	26.40	128.00	31.00	6.50	28.77	0.60	476.75
H11-0821	Na-HCO3	29.1374741	-23.3524190	8.20	117.60	899.00	54.00	51.00	124.00	15.60	36.20	136.00	41.00	10.10	44.71	0.40	432.85
H11-0823	Na-HCO3	29.1723900	-23.2650697	8.26	146.00	988.88	63.39	54.55	135.70	14.03	21.37	179.57	22.33	31.18	138.03	0.20	380.91
H11-0823	Na-HCO3	29.1723900	-23.2650697	8.26	146.00	988.88	63.39	54.55	135.70	14.03	21.37	179.57	22.33	31.18	138.03	0.20	380.91
H11-0827	Na-HCO3	29.2249765	-23.4701810	8.00	111.00	832.00	50.00	30.00	151.00	9.30	36.60	140.00	23.00	7.20	31.87	0.40	396.27
H11-0833	Na-HCO3	29.1148400	-23.4012500	8.24	130.00	752.00	64.10	54.20	132.00	12.60	34.40	171.10	30.70	12.72	56.30	0.20	361.50
H11-0833	Na-HCO3	29.1152500	-23.4005200	8.31	137.00	985.26	61.42	53.26	132.83	13.31	33.29	166.13	29.92	14.22	0.00	0.27	465.11
H11-0841	Mg-HCO3	29.0576900	-23.3420797	8.48	146.00	991.96	58.35	70.93	127.81	17.10	34.77	189.14	29.87	10.72	47.46	0.21	451.03
H11-0882	Mg-HCO3	29.1158330	-23.1527780	8.31	157.00	1173.36	74.01	95.88	109.05	10.28	34.56	150.74	53.30	5.82	0.00	0.26	654.03
H11-0885	Mg-HCO3	29.1401000	-23.2542600	8.15	116.00	878.00	40.90	83.30	84.90	11.40	43.00	135.70	30.30	5.29	23.40	0.10	397.60
H11-0885	Mg-HCO3	29.1402300	-23.2542497	8.24	113.40	879.23	37.83	75.00	88.61	11.38	39.78	116.09	25.79	4.52	20.01	0.19	504.20
H11-0885	Mg-HCO3	29.1401000	-23.2542600	8.15	116.00	878.00	40.90	83.30	84.90	11.40	43.00	135.70	30.30	5.29	23.40	0.10	397.60
H11-0885	Mg-HCO3	29.1402300	-23.2542497	8.24	113.40	879.23	37.83	75.00	88.61	11.38	39.78	116.09	25.79	4.52	20.01	0.19	504.20
H11-0915	Mg-HCO3	29.0763629	-23.0963264	8.20	151.00	1189.53	87.23	102.66	84.01	2.48	33.72	174.92	113.67	3.16	13.99	0.26	610.26
H11-0923	Mg-HCO3	29.1084700	-23.0800000	8.19	169.00	1257.69	74.36	114.14	99.65	10.95	35.93	172.71	69.91	7.97	0.00	0.24	680.25
H11-0923	Mg-HCO3	29.1084700	-23.0800000	8.19	169.00	1257.69	74.36	114.14	99.65	10.95	35.93	172.71	69.91	7.97	0.00	0.24	680.25
H11-0933	Mg-HCO3	29.1132740	-23.0925570	8.15	143.00	1004.57	65.42	80.70	97.90	8.71	38.71	139.14	51.44	5.49	24.30	0.27	536.25
H11-0933	Mg-HCO3	29.1132740	-23.0925570	8.15	143.00	1004.57	65.42	80.70	97.90	8.71	38.71	139.14	51.44	5.49	24.30	0.27	536.25
H11-0938	Mg-HCO3	29.0903132	-23.1387937	8.15	142.00	1049.02	54.27	84.95	109.44	11.17	36.79	106.50	49.48	5.30	23.46	0.25	609.41
H11-0942	Mg-HCO3	29.0861200	-23.1236600	8.22	119.10	1011.81	50.50	75.85	100.17	10.35	37.66	70.83	39.93	5.46	0.00	0.24	639.64
H11-0948	Mg-HCO3	29.1073700	-23.1158800	8.23	205.00	1492.52	97.29	132.91	128.41	11.33	33.20	293.51	83.58	16.72	0.00	0.20	671.10
H11-0954	Mg-HCO3	29.0965534	-23.1412735	8.13	195.00	1386.71	81.14	122.45	126.11	13.29	35.42	237.23	68.40	15.95	70.61	0.24	667.10
H11-0954	Mg-HCO3	29.0965534	-23.1412735	8.13	195.00	1386.71	81.14	122.45	126.11	13.29	35.42	237.23	68.40	15.95	70.61	0.24	667.10
H11-0961	Na-Cl	29.1151539	-23.1421035	8.13	105.70	689.71	41.20	28.44	128.16	3.19	35.87	162.36	73.59	8.84	39.13	0.23	213.30
H11-0966	Mg-HCO3	29.1046936	-23.1326242	8.15	158.00	1168.90	62.79	90.49	125.29	10.03	38.13	145.64	51.69	8.23	36.43	0.24	646.23

H11-0967	Mg-HCO3	29.0973734	-23.1324442	7.89	160.00	1174.42	65.32	90.24	121.68	11.06	34.65	180.39	87.07	11.51	50.95	0.18	567.46
H11-0971	Mg-HCO3	29.0372220	-23.0827780	8.28	40.20	294.51	29.17	21.02	13.65	0.59	17.27	20.17	2.00	0.47	0.00	0.24	205.48
H11-0975	Mg-HCO3	29.0276600	-23.1064800	8.22	69.20	566.08	43.23	53.33	27.84	1.94	24.37	20.74	15.44	0.88	0.00	0.28	399.33
H11-1003	Mg-Cl	28.9545592	-23.1255544	8.72	123.90	839.07	74.56	73.80	61.53	6.57	28.91	195.48	106.84	15.14	67.02	0.21	252.90
H11-1022	Mg-HCO3	28.9087079	-23.1397233	8.04	85.70	687.70	44.83	63.84	42.03	0.52	25.65	47.60	11.94	2.34	10.36	0.35	466.14
H11-1024	Mg-HCO3	28.9026077	-23.1347136	8.35	71.40	601.19	37.56	56.65	34.71	0.46	27.79	20.16	4.06	0.07	0.31	0.20	446.96
H11-1024	Mg-HCO3	28.9026077	-23.1347136	8.35	71.40	601.19	37.56	56.65	34.71	0.46	27.79	20.16	4.06	0.07	0.31	0.20	446.96
H11-1028	Mg-HCO3	28.9116879	-23.1612018	8.04	120.40	940.44	99.45	62.13	69.43	0.93	28.85	126.66	11.04	6.69	29.62	0.25	540.39
H11-1034	Na-HCO3	28.9327486	-23.1490127	7.99	144.00	972.57	62.16	54.26	147.33	0.70	20.83	187.79	4.00	2.12	9.38	0.28	508.57
H11-1042	Na-Cl	29.0533019	-23.2040884	8.55	315.00	2069.32	69.33	114.80	416.98	14.68	37.03	617.36	148.02	17.77	78.66	0.47	608.92
H11-1049	Na-Cl	29.0387216	-23.1816806	7.94	426.00	2604.63	113.29	173.12	507.15	5.77	39.59	1046.21	100.03	3.73	16.51	0.74	641.72
H11-1050	Mg-HCO3	28.9240772	-23.1490682	8.17	76.40	596.47	52.55	40.56	49.53	1.56	18.40	58.63	20.66	4.73	20.94	0.21	351.69
H11-1066	Mg-HCO3	29.0947200	-22.9952700	7.36	10.29	76.48	4.39	4.66	8.04	1.98	15.24	5.00	4.04	0.20	0.00	0.15	47.21
H11-1093	Mg-Cl	29.0680800	-23.1837400	7.88	274.00	1795.65	26.35	158.43	290.00	30.76	39.98	520.77	71.85	13.82	0.00	0.36	635.74
H11-1095	Mg-HCO3	29.1116137	-23.2060891	7.98	169.00	1161.85	63.56	97.16	128.69	11.88	28.86	213.19	33.06	4.65	20.58	0.22	593.43
H11-1098	Na-Cl	29.0429414	-23.3130015	8.05	212.00	1265.08	77.80	74.25	200.03	19.47	30.55	329.71	45.80	19.41	85.92	0.37	431.67
H11-1100	Ca-HCO3	28.9010491	-23.0105500	8.44	164.00	1085.18	149.60	34.79	118.26	0.89	33.96	229.99	51.32	21.39	94.69	0.24	405.31
H11-1102	Mg-HCO3	28.9395790	-23.0479897	8.09	98.70	763.95	73.48	58.30	48.77	1.85	10.47	84.28	8.79	0.11	0.49	0.19	487.38
H11-1107	Mg-Cl	28.7980046	-23.1480325	7.74	928.00	5392.28	657.49	424.99	598.75	32.46	27.92	3018.04	193.86	10.03	44.40	0.17	421.89
H11-1111	Na-Cl	28.7755139	-23.1382631	7.55	670.00	3755.35	347.93	263.43	603.36	9.12	16.29	2012.22	125.49	8.12	35.95	0.33	356.30
H11-1112	Mg-Cl	28.8252408	-23.1851489	6.45	27.70	148.30	10.33	9.08	16.67	2.18	13.35	36.44	8.88	9.88	43.74	0.10	20.86
H11-1113	Mg-HCO3	28.8421024	-23.1848433	7.75	39.30	267.86	26.14	16.13	19.21	1.70	7.15	34.50	5.24	0.06	0.27	0.20	164.28
H11-1120	Mg-Cl	28.8368800	-23.1918151	7.36	169.00	740.99	79.38	63.73	90.36	2.83	7.53	417.28	4.00	0.17	0.75	0.17	84.47
H11-1120	Mg-Cl	28.8368800	-23.1918151	7.36	169.00	740.99	79.38	63.73	90.36	2.83	7.53	417.28	4.00	0.17	0.75	0.17	84.47
H11-1121	Na-Cl	28.8379078	-23.1870099	7.49	98.20	519.58	52.21	28.53	82.73	1.72	0.00	254.97	4.24	0.25	1.10	0.19	93.85
H11-1121	Na-Cl	28.8379078	-23.1870099	7.49	98.20	519.58	52.21	28.53	82.73	1.72	0.00	254.97	4.24	0.25	1.10	0.19	93.85
H11-1123	Mg-Cl	28.8242408	-23.1823435	7.84	361.00	2148.00	186.42	253.85	142.65	0.85	38.55	749.12	336.37	49.41	218.73	0.10	259.87
H11-1123	Mg-Cl	28.8242408	-23.1823435	7.84	361.00	2148.00	186.42	253.85	142.65	0.85	38.55	749.12	336.37	49.41	218.73	0.10	259.87
H11-1124	Ca-HCO3	28.8242686	-23.1822879	7.43	81.50	542.95	56.06	31.14	39.83	13.22	8.76	108.48	4.75	11.76	52.06	0.30	235.35
H11-1124	Ca-HCO3	28.8242686	-23.1822879	7.43	81.50	542.95	56.06	31.14	39.83	13.22	8.76	108.48	4.75	11.76	52.06	0.30	235.35
H11-1125	Ca-HCO3	28.8243241	-23.1821768	7.19	60.60	408.61	46.54	12.25	52.42	4.84	9.71	69.67	10.95	0.05	0.22	0.15	210.54
H11-1125	Ca-HCO3	28.8243241	-23.1821768	7.19	60.60	408.61	46.54	12.25	52.42	4.84	9.71	69.67	10.95	0.05	0.22	0.15	210.54
H11-1127	Mg-Cl	28.8069624	-23.1825101	7.10	200.00	888.94	94.98	81.27	112.53	6.64	2.55	552.43	4.00	0.08	0.35	0.10	35.73
H11-1130	Na-Cl	28.8057958	-23.1818713	6.83	96.90	534.09	33.12	35.81	88.24	2.54	17.98	233.10	15.43	13.45	59.54	0.12	65.96
H11-1133	Na-Cl	28.8182683	-23.1844544	7.29	46.30	279.39	20.89	13.56	45.52	2.46	4.85	79.40	10.26	0.04	0.18	0.15	106.84
H11-1133	Na-Cl	28.8182683	-23.1844544	7.29	46.30	279.39	20.89	13.56	45.52	2.46	4.85	79.40	10.26	0.04	0.18	0.15	106.84
H11-1151	Mg-Cl	28.9912899	-23.3156212	8.11	305.00	1824.65	145.11	147.23	219.49	15.36	29.84	672.07	48.15	5.70	25.23	0.28	551.25
H11-1152	Mg-Cl	28.9947400	-23.3183811	7.94	251.00	1475.80	86.29	127.85	189.92	17.77	21.75	523.28	53.97	10.70	47.37	0.22	428.47
H11-1156	Mg-Cl	28.9876898	-23.3233907	6.98	294.00	1566.00	130.20	104.40	159.40	17.50	0.00	452.90	8.50	14.90	65.96	0.18	551.73
H11-1158	Mg-HCO3	29.0218308	-23.2894831	7.08	156.70	936.00	85.70	88.10	92.50	2.10	0.00	226.60	8.30	11.90	52.68	0.35	470.65
H11-1159	Na-HCO3	29.0104005	-23.3094117	7.19	155.60	847.00	66.30	60.90	116.80	13.80	0.00	200.60	2.00	10.80	47.81	0.45	490.28
H11-1160	Mg-Cl	29.0006902	-23.3130414	7.00	392.00	2035.00	155.20	150.00	226.20	3.20	0.00	667.30	35.50	12.50	55.34	0.32	594.41
H11-1161	Mg-HCO3	29.0000801	-23.3143914	7.32	136.60	843.00	65.10	73.10	108.90	11.80	0.00	177.90	9.00	7.50	33.20	0.43	513.57
H11-1162	Na-HCO3	29.0313911	-23.2769040	8.31	116.50	937.65	37.02	61.56	129.32	15.05	34.72	112.75	21.94	9.48	41.97	0.76	517.11
H11-1166	Na-Cl	29.0717100	-23.2683100	8.61	142.00	1039.69	26.81	62.99	194.68	16.92	38.35	232.32	116.54	8.07	0.00	0.42	353.21
H11-1168	Mg-HCO3	28.9272778	-23.2218887	8.06	183.00	1209.21	82.17	89.17	149.13	6.48	38.56	253.63	45.91	8.28	36.65	0.31	545.64

Borehole nr.	Water type	X	Y	pH	EC	TDS	Ca	Mg	Na	K	Si	Cl	SO4	N	NO3	F	HCO3
H11-1169	Mg-HCO3	28.9275560	-23.2214437	8.33	153.00	1001.88	105.54	71.24	81.44	7.17	33.59	206.25	12.96	17.84	78.97	0.24	437.96
H11-1170	Mg-HCO3	29.0428516	-23.2359069	8.14	153.00	1001.88	87.33	59.43	73.19	7.61	39.84	149.19	13.01	19.81	87.69	0.29	392.19
H11-1183	Na-HCO3	29.0639977	-23.2342292	8.40	196.00	1372.90	39.55	76.05	237.74	22.14	39.85	244.25	89.38	2.92	12.93	0.57	650.16
H11-1183	Na-HCO3	29.0639977	-23.2342292	8.40	196.00	1372.90	39.55	76.05	237.74	22.14	39.85	244.25	89.38	2.92	12.93	0.57	650.16
H11-1184	Na-HCO3	29.0724000	-23.2269997	8.31	169.00	1252.53	42.33	69.91	194.72	24.61	39.86	130.01	57.80	31.28	138.47	0.61	593.92
H11-1184	Na-HCO3	29.0724000	-23.2269997	8.31	169.00	1252.53	42.33	69.91	194.72	24.61	39.86	130.01	57.80	31.28	138.47	0.61	593.92
H11-1186	Na-Cl	28.9954958	-23.1949818	7.64	977.00	5891.97	328.31	472.15	1149.62	24.69	38.89	3419.35	60.56	13.86	61.36	0.29	375.57
H11-1187	Na-Cl	28.9924680	-23.1815939	7.83	233.00	1364.22	97.92	74.56	188.28	0.59	34.22	287.46	29.14	103.46	458.00	0.21	227.86
H11-1195	Ca-HCO3	29.0203299	-23.1872324	8.20	75.70	490.61	55.53	22.46	47.59	10.41	4.47	105.62	56.98	2.12	9.38	0.26	182.21
H11-1195	Ca-HCO3	29.0203299	-23.1872324	8.20	75.70	490.61	55.53	22.46	47.59	10.41	4.47	105.62	56.98	2.12	9.38	0.26	182.21
H11-1196	Ca-Cl	28.9983015	-23.1874268	7.61	127.60	770.03	93.66	47.48	56.41	40.47	6.39	257.87	84.81	2.84	12.56	0.14	174.75
H11-1196	Ca-Cl	28.9983015	-23.1874268	7.61	127.60	770.03	93.66	47.48	56.41	40.47	6.39	257.87	84.81	2.84	12.56	0.14	174.75
H11-1198	Na-Cl	28.9899679	-23.1893711	7.02	54.50	294.38	24.54	10.88	42.35	3.31	15.02	105.19	15.52	0.26	1.15	0.12	89.56
H11-1199	Na-Cl	29.0256356	-23.1905933	7.95	873.00	5243.52	184.71	330.59	1263.60	6.79	37.37	2795.20	220.80	1.83	8.10	0.87	432.71
H11-1204	Mg-HCO3	28.9281200	-23.2408797	7.88	158.00	1029.55	96.29	67.46	112.52	1.69	39.60	221.60	18.04	18.46	81.72	0.26	429.83
H11-1208	Na-Cl	28.9390700	-23.2302197	8.01	1.77	1192.68	106.39	47.71	178.05	2.09	33.30	287.32	44.27	16.17	71.58	0.46	454.65
H11-1216	Na-Cl	28.9619400	-23.1919397	8.09	464.00	2687.55	181.32	173.04	479.28	3.21	30.97	1163.90	19.53	11.63	51.50	0.72	615.01
H11-1217	Mg-HCO3	28.8571300	-23.2457397	7.88	56.20	376.38	25.07	25.98	42.69	2.36	5.60	58.92	11.51	0.65	2.88	0.22	206.70
H11-1217	Mg-HCO3	28.8571300	-23.2457397	7.88	56.20	376.38	25.07	25.98	42.69	2.36	5.60	58.92	11.51	0.65	2.88	0.22	206.70
H11-1221	Na-Cl	28.8643200	-23.2345100	7.49	32.00	173.98	10.63	8.50	21.17	4.03	7.57	47.12	2.00	8.62	0.00	0.13	42.09
H11-1229	Mg-Cl	28.8587974	-23.1880098	6.96	23.30	115.50	8.78	7.50	9.52	1.08	12.62	25.15	4.00	7.21	31.90	0.11	29.34
H11-1229	Mg-Cl	28.8587974	-23.1880098	6.96	23.30	115.50	8.78	7.50	9.52	1.08	12.62	25.15	4.00	7.21	31.90	0.11	29.34
H11-1232	Na-Cl	28.8839500	-23.1863697	7.44	73.60	395.40	45.85	18.24	56.17	0.65	23.27	170.56	4.00	2.40	10.62	0.25	90.97
H11-1244	Na-HCO3	28.8877600	-23.1672197	7.59	149.00	934.71	79.46	42.19	144.35	0.68	30.29	237.90	6.79	1.88	8.32	0.39	414.49
H11-1251	Mg-Cl	28.7919044	-23.1310437	8.12	298.00	1683.91	150.58	151.30	185.00	2.46	93.06	581.56	71.59	8.78	38.87	0.36	502.11
H11-1252	Mg-Cl	28.7932945	-23.1315936	8.21	418.00	2483.41	183.30	202.62	355.04	2.25	32.59	978.12	147.26	16.71	73.97	0.33	540.39
H11-1256	Na-Cl	28.7979898	-23.2524497	7.00	41.20	196.87	7.26	8.90	43.15	2.37	12.77	81.44	18.92	0.19	0.84	0.14	33.64
H11-1260	Ca-Cl	28.7758438	-23.2265770	7.64	116.60	680.25	89.16	31.19	85.03	3.09	9.11	257.48	20.48	0.11	0.49	0.24	192.02
H11-1264	Na-Cl	28.7104873	-23.2316176	7.38	521.00	2963.92	269.45	158.70	522.33	4.96	11.09	1659.92	160.44	0.11	0.49	0.18	187.13
H11-1265	Na-HCO3	28.7125719	-23.2297366	7.79	68.50	469.27	43.03	13.66	62.14	8.46	9.16	79.33	13.69	0.07	0.29	0.23	247.87
H11-1266	Mg-Cl	28.7124596	-23.2235348	7.58	486.00	2946.00	296.30	205.20	375.50	5.60	31.10	1197.10	212.60	4.60	20.36	0.30	632.82
H11-1267	Na-Cl	28.7161261	-23.2176186	7.70	214.00	1167.49	43.17	52.25	250.92	17.18	44.24	424.56	74.49	2.87	12.70	0.29	291.86
H11-1268	Na-Cl	28.7158483	-23.2152021	7.84	963.00	5672.83	198.61	242.40	1399.07	61.79	42.41	2965.29	326.34	2.61	11.55	0.94	466.74
H11-1272	Na-HCO3	28.7085818	-23.2176575	7.90	95.20	653.18	33.20	19.66	130.91	9.65	21.30	150.85	4.62	0.05	0.22	0.26	302.51
H11-1274	Na-HCO3	28.7034317	-23.2177475	8.17	157.00	1083.58	56.97	44.80	198.55	6.05	32.31	201.00	26.46	2.49	11.02	0.90	537.10
H11-1276	Na-HCO3	28.7041534	-23.2197295	8.12	195.00	1280.93	73.08	51.98	215.56	5.72	39.29	243.77	37.64	29.20	129.26	1.13	522.71
H11-1277	Na-Cl	28.7035717	-23.2203173	8.44	265.00	1724.16	89.70	75.97	318.15	5.01	28.40	402.26	44.44	73.50	325.37	0.85	462.30
H11-1279	Mg-NO3	28.7096814	-23.2235348	7.12	120.40	837.40	81.17	55.83	76.66	9.37	29.40	175.14	4.00	84.38	373.53	0.15	63.93
H11-1281	Mg-HCO3	28.7194021	-23.1668710	8.50	105.80	836.10	60.08	55.01	91.22	2.99	40.09	64.17	25.53	22.31	98.76	0.55	434.66
H11-1282	Na-HCO3	28.7411328	-23.2109680	8.16	214.00	1432.95	50.17	48.54	329.31	14.08	39.76	309.86	80.41	12.18	53.92	1.19	545.39
H11-1290	Mg-Cl	28.7052318	-23.1274297	7.76	330.00	1896.74	177.71	147.97	236.90	1.69	35.85	738.83	45.14	14.02	62.06	0.56	485.79
H11-1292	Mg-HCO3	28.7441230	-23.1074352	8.20	305.00	2237.00	113.00	178.00	313.00	1.90	33.10	464.00	149.00	4.80	21.25	0.70	997.39
H11-1303	Na-HCO3	28.7032918	-23.0357701	7.78	90.60	773.95	33.91	4.19	167.66	1.62	17.56	89.48	94.51	3.22	14.25	0.48	368.02
H11-1311	Mg-HCO3	28.8004549	-23.0384701	8.25	147.00	972.29	85.90	58.83	107.75	4.20	34.32	158.34	8.35	33.14	146.70	0.32	401.84
H11-1315	Mg-HCO3	28.8194053	-23.1024357	8.55	120.30	874.30	70.88	69.20	78.12	0.83	37.92	134.84	17.15	19.78	87.56	0.43	415.22

Borehole nr.	Water type	X	Y	pH	EC	TDS	Ca	Mg	Na	K	Si	Cl	SO4	N	NO3	F	HCO3
H11-1368	Mg-Cl	28.9875000	-23.2072220	7.83	689.00	4235.29	303.06	366.73	664.86	16.78	35.58	2415.66	37.96	20.53	0.00	0.67	338.55
H11-1370	Na-Cl	29.0019904	-23.2123884	7.61	120.50	696.41	50.60	43.82	119.27	4.44	33.98	301.98	16.37	1.46	6.46	0.30	153.08
H11-1371	Na-Cl	28.9979963	-23.2084257	8.64	463.00	2792.83	182.90	191.80	471.12	8.93	34.74	1253.23	83.06	9.28	41.08	0.37	560.27
H11-1372	Mg-HCO3	29.0144108	-23.2148283	7.77	99.70	710.04	71.22	51.90	54.33	3.67	48.76	120.17	11.06	18.70	82.78	0.20	314.62
H11-1372	Mg-HCO3	29.0144108	-23.2148283	7.77	99.70	710.04	71.22	51.90	54.33	3.67	48.76	120.17	11.06	18.70	82.78	0.20	314.62
H11-1380	Na-Cl	28.7767937	-23.2863128	7.73	12.00	59.89	4.26	4.06	9.35	1.52	10.97	19.26	10.26	0.04	0.18	0.12	10.89
H11-1392	Mg-HCO3	29.1010824	-23.2035372	8.00	138.00	1042.00	49.00	84.00	121.00	12.50	31.90	149.00	35.00	6.50	28.77	0.20	562.10
H11-1411	Mg-HCO3	29.1700000	-23.3102774	8.50	115.10	847.00	36.00	82.00	81.00	11.10	49.60	140.00	31.00	13.60	60.20	0.20	406.03
H11-1411	Mg-HCO3	29.1700000	-23.3102774	8.50	115.10	847.00	36.00	82.00	81.00	11.10	49.60	140.00	31.00	13.60	60.20	0.20	406.03
H11-1452	Ca-HCO3	28.9490491	-23.1359536	7.96	55.20	451.81	42.78	20.74	45.11	1.50	21.47	21.11	13.48	1.18	5.22	0.21	301.58
H11-1465	Na-HCO3	29.1514300	-23.3831700	7.94	144.00	1254.60	57.60	61.05	144.35	13.97	33.98	156.05	28.44	55.94	0.00	0.42	545.03
H11-1487	Na-HCO3	29.1748400	-23.4173000	8.26	98.80	762.75	48.11	35.08	101.99	9.05	36.75	83.36	16.91	13.08	0.00	0.31	409.92
H11-1487	Na-HCO3	29.1748400	-23.4173000	8.26	98.80	762.75	48.11	35.08	101.99	9.05	36.75	83.36	16.91	13.08	0.00	0.31	409.92
H11-1498	Na-HCO3	29.0953038	-23.3645261	7.99	147.00	953.42	56.24	64.30	129.63	18.53	33.90	219.35	23.29	3.16	13.99	0.21	427.72
H11-1505	Na-Cl	28.8732667	-23.1862600	6.86	22.30	104.10	6.62	4.40	18.35	0.88	14.23	36.61	4.00	6.69	29.62	0.12	5.15
H11-1506	Ca-HCO3	28.8788869	-23.1782705	7.39	38.30	271.08	45.99	5.36	12.42	2.78	12.36	18.69	4.96	4.13	18.28	0.19	162.30
H11-1530	Mg-HCO3	29.0914630	-23.2276875	8.50	189.00	1305.74	64.21	98.82	164.61	12.69	36.13	251.77	46.33	24.42	108.10	0.24	558.81
H11-1530	Mg-HCO3	29.0914630	-23.2276875	8.50	189.00	1305.74	64.21	98.82	164.61	12.69	36.13	251.77	46.33	24.42	108.10	0.24	558.81
H11-1534	Na-HCO3	29.1180300	-23.3439400	8.48	153.00	1084.54	58.23	64.97	158.88	18.36	36.74	212.96	52.01	11.95	0.00	0.37	465.85
H11-1563	Ca-NO3	28.7055154	-23.0210489	8.20	186.00	1349.06	149.80	89.91	86.55	1.19	39.77	112.80	76.63	112.89	499.74	0.34	332.00
H11-1648	Mg-HCO3	29.0944150	-23.3763028	8.33	159.00	1034.63	68.75	71.99	129.08	17.72	30.68	243.32	29.49	7.71	34.13	0.21	439.58
H11-1652	Mg-HCO3	29.0833300	-23.3613800	8.33	150.00	1030.67	60.97	72.64	132.46	17.04	35.72	240.04	41.70	5.85	0.00	0.21	439.47
H11-1652	Mg-HCO3	29.0833300	-23.3613800	8.33	150.00	1030.67	60.97	72.64	132.46	17.04	35.72	240.04	41.70	5.85	0.00	0.21	439.47
H11-1653	Mg-HCO3	29.0872200	-23.3630600	8.34	159.00	1033.47	58.58	82.13	127.16	15.59	35.49	249.09	26.28	6.62	0.00	0.21	444.98
H11-1653	Mg-HCO3	29.0872200	-23.3630600	8.34	159.00	1033.47	58.58	82.13	127.16	15.59	35.49	249.09	26.28	6.62	0.00	0.21	444.98
H11-1654	Mg-HCO3	29.0913800	-23.3644400	8.33	163.00	1046.45	62.64	82.12	131.15	18.62	32.84	254.57	25.53	5.75	0.00	0.19	445.65
H11-1658	Mg-HCO3	29.0950000	-23.3572200	8.36	124.20	879.95	37.47	71.69	110.59	12.16	39.40	159.93	23.67	7.77	0.00	0.24	429.53
H11-1659	Na-HCO3	29.0983300	-23.3530600	8.27	113.80	871.14	47.23	52.30	108.43	17.36	36.24	139.13	16.01	18.40	0.00	0.32	408.74
H11-1661	Na-HCO3	29.0983300	-23.3530600	8.48	125.50	917.86	50.02	52.91	138.85	16.17	34.73	149.91	18.91	9.71	0.00	0.29	447.66
H11-1672	Na-HCO3	29.1183300	-23.3783300	8.58	120.80	924.43	57.97	50.93	133.98	16.71	33.38	159.71	39.19	8.46	0.00	0.38	427.89
H11-1673	Mg-Cl	28.9958014	-23.1927042	7.97	679.00	4029.12	209.16	383.73	665.89	5.77	37.59	2120.47	28.57	5.54	24.54	1.63	589.29
H11-1674	Mg-Cl	29.0079685	-23.1741222	7.84	252.00	1395.44	164.54	122.08	109.28	3.06	19.45	525.34	23.63	1.20	5.31	0.28	441.86
H11-1675	Mg-Cl	29.0081907	-23.1741500	8.05	211.00	1211.15	128.18	100.95	113.48	3.77	14.67	409.01	9.68	0.05	0.22	0.25	445.48
H11-1688	Mg-HCO3	28.9200000	-23.1391670	8.40	85.80	704.00	57.30	70.20	29.10	1.32	22.00	53.70	4.10	1.15	0.00	0.18	482.96
H11-1738	Mg-Cl	28.7116264	-23.1315968	7.74	498.00	2666.51	269.15	229.48	349.54	5.76	30.44	1401.96	65.18	20.68	91.55	0.23	253.55
H11-1740	Na-Cl	28.6916256	-23.1313190	8.08	347.00	2312.70	146.95	151.10	373.79	2.42	24.50	773.38	60.18	1.02	4.52	0.51	799.74
H11-1743	Na-Cl	29.0444100	-23.0002750	7.73	56.70	347.45	33.94	2.61	74.93	0.69	12.61	110.85	29.19	0.94	0.00	0.28	90.72
H11-1747	Na-HCO3	29.1962200	-23.3527600	8.52	128.00	1016.93	67.07	53.62	152.70	12.85	20.80	177.19	19.37	7.61	0.00	0.26	499.06
H11-1747	Na-HCO3	29.1962200	-23.3527600	8.52	128.00	1016.93	67.07	53.62	152.70	12.85	20.80	177.19	19.37	7.61	0.00	0.26	499.06
H11-1748	Na-HCO3	29.1964700	-23.3523700	8.17	125.50	995.88	61.47	45.67	142.33	10.20	29.98	143.41	21.84	20.00	0.00	0.29	482.08
H11-1748	Na-HCO3	29.1964700	-23.3523700	8.17	125.50	995.88	61.47	45.67	142.33	10.20	29.98	143.41	21.84	20.00	0.00	0.29	482.08
H11-1750	Na-Cl	29.1809200	-23.3413900	8.21	202.00	1297.80	88.13	59.25	206.92	16.95	35.17	319.01	39.61	12.73	0.00	0.25	511.25
H11-1752	Na-HCO3	29.1827900	-23.3478500	8.46	167.00	1104.69	51.24	59.70	174.86	12.76	16.63	232.06	35.16	15.99	0.00	0.38	464.63
H11-1752	Na-HCO3	29.1827900	-23.3478500	8.46	167.00	1104.69	51.24	59.70	174.86	12.76	16.63	232.06	35.16	15.99	0.00	0.38	464.63
H11-1753	Na-Cl	29.2006100	-23.3418300	8.23	250.00	1526.52	98.20	85.19	203.81	16.48	32.84	390.89	53.96	74.68	0.00	0.28	345.92

Borehole nr.	Water type	X	Y	pH	EC	TDS	Ca	Mg	Na	K	Si	Cl	SO4	N	NO3	F	HCO3
H11-1763	Mg-HCO3	29.2006100	-23.3453500	8.20	148.00	1006.82	81.63	72.91	102.82	14.73	36.46	207.28	34.24	6.31	0.00	0.21	464.82
H11-1763	Mg-HCO3	29.2006100	-23.3453500	8.20	148.00	1006.82	81.63	72.91	102.82	14.73	36.46	207.28	34.24	6.31	0.00	0.21	464.82
H11-1764	Mg-HCO3	29.2001500	-23.3463400	8.22	165.00	1093.13	92.99	73.54	125.63	13.53	28.35	239.71	27.72	11.47	0.00	0.23	468.82
H11-1764	Mg-HCO3	29.2001500	-23.3463400	8.22	165.00	1093.13	92.99	73.54	125.63	13.53	28.35	239.71	27.72	11.47	0.00	0.23	468.82
H11-1765	Na-HCO3	29.1996300	-23.3471400	7.98	142.00	1019.80	76.18	64.31	128.16	14.11	32.40	178.35	22.46	9.18	0.00	0.25	495.28
H11-1766	Na-HCO3	29.1994700	-23.3473600	8.17	118.30	910.58	61.68	55.64	106.59	14.92	17.72	168.18	27.82	1.94	0.00	0.32	465.81
H11-1781	Na-HCO3	29.1614900	-23.3201100	8.63	164.00	1167.68	60.54	80.87	173.23	12.26	33.18	263.10	56.01	6.62	0.00	0.24	492.11
H11-1783	Na-Cl	29.1559400	-23.3263900	8.40	212.00	1220.65	25.91	91.89	245.14	12.21	1.97	446.22	62.42	0.06	0.00	0.10	334.41
H11-1785	Na-HCO3	29.1536100	-23.3272200	8.08	182.00	1183.71	76.98	64.17	172.19	13.04	3.25	277.15	38.16	1.35	0.00	0.26	535.76
H11-1786	Na-Cl	29.1552600	-23.3281900	8.22	186.00	1095.18	11.99	78.56	219.35	15.88	2.26	364.78	55.16	0.86	0.00	0.22	345.37
H11-1803	Na-HCO3	29.1366400	-23.3835600	8.33	118.80	916.85	48.27	46.93	130.31	12.94	35.54	126.09	29.64	9.27	0.00	0.41	481.14
H11-1819	Mg-Cl	29.3529000	-23.3252000	8.35	265.00	1504.91	93.42	147.13	178.50	23.30	34.92	570.85	183.42	12.98	0.00	0.21	250.56
H11-1823	Mg-HCO3	29.0593800	-23.3442100	8.48	158.00	1062.65	65.03	76.61	119.46	18.70	35.61	205.34	44.40	17.33	0.00	0.20	456.06
H11-1823	Mg-HCO3	29.0593800	-23.3442100	8.48	158.00	1062.65	65.03	76.61	119.46	18.70	35.61	205.34	44.40	17.33	0.00	0.20	456.06
H11-1839	Na-Cl	28.9375000	-23.2233300	8.21	355.00	2165.91	186.66	91.38	369.65	3.78	36.55	836.20	47.06	22.92	0.00	0.52	529.18
H11-1843	Na-Cl	29.0600000	-23.1372220	8.17	760.00	4948.68	14.82	251.43	1337.78	29.32	15.66	2104.26	489.86	0.04	0.00	0.53	720.36
H11-1846	Mg-HCO3	29.0841500	-23.2177100	8.37	170.00	1205.94	47.21	86.14	160.63	17.16	12.23	221.77	44.50	0.34	0.00	0.26	620.87
H11-1848	Na-Cl	28.9376900	-23.2291400	8.19	442.00	2472.84	224.24	142.15	405.36	1.86	33.99	1137.54	37.67	21.86	0.00	0.36	426.76
H11-1855	Na-Cl	28.9972500	-23.2371200	7.63	543.00	3193.15	171.18	195.55	604.18	13.09	27.53	1316.47	98.62	52.04	0.00	0.31	563.32
H11-1872	Na-Cl	28.9596900	-23.2118300	7.86	452.00	2582.81	287.69	149.47	411.09	2.42	28.91	1284.58	27.07	36.23	0.00	0.31	259.55
H11-1874	Na-Cl	28.9356200	-23.2220100	7.94	279.00	1797.24	117.27	68.01	385.25	1.29	36.01	559.38	56.69	14.35	0.00	0.80	545.03
H11-1882	Mg-HCO3	29.1167100	-23.1510400	8.00	139.00	882.00	70.80	90.80	109.00	9.80	38.10	138.50	61.30	4.45	19.70	0.20	519.50
H11-1893	Na-Cl	29.0211000	-23.3045500	8.30	196.00	1278.70	105.67	70.91	171.50	12.67	19.21	293.01	41.23	34.55	0.00	0.23	430.52
H11-1916	Mg-Cl	28.8460748	-23.1888153	7.54	239.00	1177.26	112.40	94.73	150.99	1.22	28.57	550.34	9.99	9.34	41.35	0.19	215.97
H11-1957	Na-Cl	28.9817700	-23.2214700	8.14	564.00	2969.69	332.97	201.47	404.37	7.88	34.97	1604.12	23.28	26.21	0.00	0.30	279.15
H11-1976	Mg-Cl	28.9708285	-23.1892044	7.68	909.00	5551.97	486.29	566.61	675.19	1.56	38.27	3318.94	30.22	12.64	55.95	0.30	416.51
H11-1979	Ca-Cl	29.0284968	-23.1817606	7.72	582.00	3477.90	573.46	303.90	148.12	4.62	40.64	1720.51	395.30	30.83	136.48	0.15	195.28
H11-1980	Ca-SO4	29.0229134	-23.1790386	7.96	173.00	1142.71	159.77	23.02	144.49	2.26	42.24	148.61	378.10	8.55	37.85	0.60	247.94
H11-1981	Na-HCO3	29.0216911	-23.1789830	8.17	77.80	540.72	33.92	18.31	90.55	4.12	20.59	75.45	55.02	11.34	50.20	0.63	212.46
H11-1982	Ca-HCO3	28.8569640	-23.1881487	7.08	50.10	309.15	36.65	21.61	15.36	1.00	33.34	55.41	6.22	11.37	50.33	0.18	122.25
H11-1984	Mg-Cl	28.8556028	-23.1873432	7.51	112.30	714.24	97.01	66.00	24.05	1.18	39.41	263.02	6.17	18.50	81.89	0.13	174.70
H11-1989	Na-Cl	28.7949619	-23.2540607	7.53	193.00	991.40	62.71	59.50	187.21	4.70	23.81	420.80	64.93	3.33	14.74	0.16	176.57
H11-1990	Na-Cl	28.7980176	-23.2523386	7.28	25.00	130.31	8.39	6.56	20.41	1.27	11.29	41.28	5.24	0.17	0.77	0.12	46.23
H11-1995	Na-Cl	29.0078851	-23.1739833	8.08	164.00	955.22	96.04	54.82	125.10	2.23	15.73	358.85	16.12	0.06	0.27	0.22	301.47
H11-2000	Mg-Cl	28.7007090	-23.2287567	8.02	104.60	717.85	75.66	48.58	60.62	8.50	18.95	184.86	20.95	16.64	73.66	0.26	244.66
H11-2001	Mg-HCO3	28.8470470	-23.1865932	8.34	38.10	312.14	30.55	19.42	21.40	0.85	39.68	20.74	4.40	1.15	5.10	0.23	209.35
H11-2004	Na-HCO3	29.0655500	-23.3300200	7.96	184.00	1239.82	73.55	73.21	185.50	18.84	33.93	246.43	30.73	31.31	0.00	0.29	472.50
H11-2011	Na-Cl	28.9793000	-23.2388300	7.76	780.00	4295.79	484.65	229.87	733.31	7.31	30.07	2446.48	117.76	22.11	0.00	0.27	178.19
H11-2051	Na-Cl	28.9924700	-23.2231000	8.39	224.00	1284.81	35.69	70.14	275.23	5.32	35.28	427.07	37.85	16.82	0.00	0.60	358.36
H11-2068	Na-Cl	29.0430560	-23.2275000	8.39	199.00	1321.97	34.49	94.09	190.46	5.66	37.22	258.92	43.88	60.19	0.00	0.32	427.54
H11-2069	Na-Cl	29.0459300	-23.2193400	8.24	316.00	2028.19	63.18	86.47	440.73	7.18	1.05	436.61	132.21	59.86	0.00	0.47	596.24
H11-2092	Na-HCO3	29.1599600	-23.3801300	8.28	142.00	1020.36	64.66	62.99	137.64	16.47	26.91	173.46	28.84	18.90	0.00	0.25	452.30
H11-2093	Na-HCO3	29.1628700	-23.3764400	7.94	93.30	722.92	45.41	37.83	95.83	14.62	31.80	77.62	23.69	8.66	0.00	0.28	389.27
H11-2096	Na-HCO3	29.1103400	-23.3680300	8.52	108.30	773.69	28.38	43.97	109.40	31.25	35.70	152.00	22.10	6.44	0.00	0.10	357.83
H11-2097	Na-Cl	29.0450900	-23.2191100	8.04	327.00	1982.63	90.09	140.83	320.64	7.25	39.67	742.44	107.03	33.70	0.00	0.36	424.70

Borehole nr.	Water type	X	Y	pH	EC	TDS	Ca	Mg	Na	K	Si	Cl	SO4	N	NO3	F	HCO3
H11-2098	Na-Cl	29.0444300	-23.2189600	8.17	566.00	3697.10	151.24	278.16	595.58	7.47	39.68	1822.27	189.44	15.42	0.00	0.44	584.04
H11-2101	Na-Cl	28.9598500	-23.1955800	7.75	730.00	3843.22	266.71	271.33	761.98	1.27	27.25	2275.15	22.27	15.54	0.00	0.27	175.13
H11-2102	Na-HCO3	28.9817800	-23.2254800	8.05	141.00	941.55	53.78	57.43	155.95	6.99	30.29	227.48	11.84	0.12	0.00	0.65	426.84
H11-2103	Na-Cl	28.9817600	-23.2254000	8.06	205.00	1228.77	32.42	52.28	283.44	5.41	26.83	346.81	16.59	0.54	0.00	0.40	488.94
H11-2104	Na-Cl	28.9826600	-23.2286300	7.51	553.00	3033.19	338.02	166.11	443.65	3.33	31.66	1492.36	48.99	18.35	0.00	0.31	459.14
H11-2105	Na-Cl	28.9828700	-23.2293000	8.06	401.00	2228.05	156.06	114.63	408.63	5.86	33.54	1093.09	59.92	16.90	0.00	0.37	314.60
H11-2109	Na-HCO3	29.0775000	-23.3900000	8.27	154.00	1031.00	62.10	70.20	138.30	13.65	31.98	230.40	29.40	5.12	0.00	0.19	463.46
H11-2109	Na-HCO3	29.0775000	-23.3900000	8.27	154.00	1031.00	62.10	70.20	138.30	13.65	31.98	230.40	29.40	5.12	0.00	0.19	463.46
H11-2110	Na-HCO3	29.0794900	-23.3894600	8.38	314.00	2178.36	19.03	170.09	366.75	47.19	39.70	499.75	134.34	5.37	0.00	0.37	916.91
H11-2110	Na-HCO3	29.0794900	-23.3894600	8.38	314.00	2178.36	19.03	170.09	366.75	47.19	39.70	499.75	134.34	5.37	0.00	0.37	916.91
H11-2112	Na-Cl	29.0572900	-23.1814500	8.21	474.00	3076.39	53.59	193.51	672.09	28.18	34.66	1066.03	233.60	5.12	0.00	0.58	805.96
H11-2113	Na-Cl	29.0594900	-23.1850300	8.30	351.00	2513.57	26.86	184.78	492.04	40.52	34.38	896.34	168.81	1.96	0.00	0.43	695.00
H11-2116	Na-HCO3	29.0763900	-23.1662900	8.29	242.00	1683.94	33.47	73.46	355.58	30.77	39.61	276.32	111.94	3.41	0.00	0.50	786.45
H11-2120	Na-Cl	29.0573200	-23.1707300	8.20	1840.00	13484.63	126.58	636.81	3286.81	194.48	23.91	7131.68	1302.82	0.62	0.00	0.35	802.30
H11-2123	Mg-HCO3	28.9875500	-23.1208200	8.07	37.20	284.42	28.13	18.37	13.94	0.79	38.63	11.72	4.50	0.14	0.00	0.26	206.02
H11-2123	Mg-HCO3	28.9875500	-23.1208200	8.07	37.20	284.42	28.13	18.37	13.94	0.79	38.63	11.72	4.50	0.14	0.00	0.26	206.02
H11-2124	Ca-HCO3	28.9847200	-23.1162900	8.35	53.70	437.01	42.02	15.64	46.01	1.74	29.51	26.77	7.74	0.04	0.00	0.41	296.39
H11-2126	Ca-Cl	28.9017200	-23.2077200	7.54	243.00	1061.61	198.78	77.54	86.97	0.82	39.63	576.40	2.00	0.04	0.00	0.22	118.57
H11-2127	Na-HCO3	29.0231300	-23.1783300	9.13	163.00	1351.39	23.43	85.48	182.11	7.70	41.67	157.11	43.66	4.52	0.00	0.29	831.56
H11-2128	Mg-HCO3	29.0960100	-23.2314800	8.28	171.00	1229.41	46.98	92.52	161.23	24.66	28.78	202.94	121.95	6.76	0.00	0.24	548.69
H11-2129	Na-HCO3	29.1029200	-23.2504700	8.26	185.00	1308.72	60.73	89.87	192.16	17.76	38.24	235.38	44.27	36.16	0.00	0.25	508.20
H11-2183	Na-HCO3	28.9028500	-23.2117700	8.13	60.70	394.60	38.92	18.22	47.89	0.52	41.24	88.86	4.92	8.26	0.00	0.37	158.13
H11-2184	Na-Cl	28.9101500	-23.2099200	7.78	685.00	3508.80	414.38	256.53	515.89	1.29	29.57	2081.66	8.30	15.71	0.00	0.11	160.79
H11-2212	Mg-HCO3	29.1647900	-23.4005200	8.08	126.00	802.00	56.10	64.00	120.00	10.30	37.70	143.80	27.80	9.51	42.10	0.20	426.30
H11-2212	Mg-HCO3	29.1647900	-23.4005200	8.08	126.00	802.00	56.10	64.00	120.00	10.30	37.70	143.80	27.80	9.51	42.10	0.20	426.30
H11-2213	Mg-Cl	28.9909300	-23.3189000	8.18	261.00	1546.38	71.85	144.63	199.24	18.57	29.17	608.11	55.62	12.30	0.00	0.36	393.50
H11-2216	Na-Cl	28.9374600	-23.2236400	7.83	349.00	2050.14	210.68	107.21	335.86	5.43	35.52	800.74	26.40	26.52	0.00	0.67	445.66
H11-2240	Na-HCO3	29.1616900	-23.3995800	8.18	113.60	918.19	59.44	47.94	129.43	12.44	33.75	120.19	21.02	7.02	0.00	0.36	496.26
H11-2270	Mg-HCO3	29.1252200	-23.1757700	8.26	170.00	1195.39	17.78	114.76	167.20	14.22	30.83	226.96	158.77	6.99	0.00	0.36	464.31
H11-2271	Mg-HCO3	29.1493600	-23.5994000	8.11	205.00	1229.07	75.06	104.90	139.79	13.10	34.49	249.43	170.19	1.83	0.00	0.24	468.21
H11-2272	Mg-HCO3	29.1621900	-23.1720300	8.24	11.15	918.77	51.22	76.26	89.09	10.55	36.61	77.98	39.94	4.10	0.00	0.25	555.27
H11D1583	Na-Cl	28.6982914	-23.1917292	8.08	264.00	1738.11	39.97	39.18	459.56	5.33	37.61	454.37	61.08	0.90	3.98	1.55	673.05
H11W1988	Mg-Cl	29.0029405	-23.1791496	7.16	92.50	523.15	45.61	36.63	45.73	20.21	14.87	154.16	5.51	43.74	193.64	0.14	21.42
H11W1988	Mg-Cl	29.0029405	-23.1791496	7.16	92.50	523.15	45.61	36.63	45.73	20.21	14.87	154.16	5.51	43.74	193.64	0.14	21.42
H16-0001	Na-HCO3	29.7838750	-23.9565388	8.10	114.80	914.00	54.00	53.00	123.00	2.80	24.20	120.00	29.00	29.80	131.92	0.50	401.15
H16-0002	Mg-HCO3	29.7926922	-23.9901108	8.00	154.00	1018.00	74.00	88.00	82.00	4.80	24.00	149.00	61.00	56.60	250.56	0.50	308.48
H16-0002	Mg-HCO3	29.7926922	-23.9901108	8.00	154.00	1018.00	74.00	88.00	82.00	4.80	24.00	149.00	61.00	56.60	250.56	0.50	308.48
H16-0003	Na-HCO3	29.7933253	-23.9901466	8.40	63.60	483.00	39.00	27.00	56.00	1.10	4.80	47.00	24.00	5.70	25.23	0.40	263.37
H16-0003A	Mg-HCO3	29.7930486	-23.9898766	8.40	75.20	591.00	46.00	34.00	62.00	1.50	21.50	65.00	30.00	12.21	54.05	0.50	297.51
H16-0003A	Mg-HCO3	29.7930486	-23.9898766	8.40	75.20	591.00	46.00	34.00	62.00	1.50	21.50	65.00	30.00	12.21	54.05	0.50	297.51
H16-0004	Mg-HCO3	29.7933253	-23.9865368	8.30	167.00	1279.00	113.00	92.00	115.00	5.30	25.00	172.00	68.00	50.80	224.88	0.60	487.72
H16-0004	Mg-HCO3	29.7933253	-23.9865368	8.30	167.00	1279.00	113.00	92.00	115.00	5.30	25.00	172.00	68.00	50.80	224.88	0.60	487.72
H16-0005	Na-HCO3	29.7980277	-23.9800827	8.10	43.70	330.00	24.00	15.00	45.00	0.90	20.40	27.00	12.00	0.30	1.33	0.50	204.84
H16-0005A	Na-HCO3	29.7972189	-23.9807072	8.30	46.30	337.00	27.00	17.00	44.00	1.30	9.90	41.00	18.00	0.00	0.00	0.30	187.77
H16-0006	Na-HCO3	29.7924986	-23.9937663	8.20	70.10	531.00	37.00	27.00	74.00	0.80	21.30	62.00	24.00	5.00	22.13	0.50	284.10

Borehole nr.	Water type	X	Y	pH	EC	TDS	Ca	Mg	Na	K	Si	Cl	SO4	N	NO3	F	HCO3
H16-0008	Mg-HCO3	29.7974955	-24.0073754	8.30	81.00	579.00	55.00	41.00	47.00	2.00	18.20	52.00	26.00	8.90	39.40	0.40	317.02
H16-0009	Mg-HCO3	29.8067222	-23.9978330	8.50	62.60	521.00	40.00	37.00	38.00	7.50	14.60	27.00	23.00	10.00	44.27	0.40	303.61
H16-0011	Mg-HCO3	29.8124998	-24.0207045	8.20	84.20	610.00	61.00	45.00	37.00	2.10	17.10	56.00	34.00	28.20	124.84	0.30	249.96
H16-0014	Na-HCO3	29.7330427	-24.0287638	8.50	63.60	515.00	39.00	24.00	66.00	2.90	14.70	42.00	12.00	2.80	12.40	0.40	315.80
H16-0016	Na-HCO3	29.6990830	-24.0519717	8.30	85.50	683.00	58.00	29.00	88.00	1.70	26.50	64.00	13.00	7.20	31.87	0.70	397.49
H16-0018	Ca-HCO3	29.6663822	-24.0309836	8.10	76.00	580.00	63.00	26.00	61.00	15.00	22.50	63.00	27.00	13.10	57.99	1.60	278.00
H16-0022	Mg-HCO3	29.6782220	-24.0450274	8.40	123.10	910.00	85.00	54.00	94.00	1.90	25.80	118.00	52.00	49.10	217.36	0.50	287.75
H16-0025	Mg-HCO3	29.7116592	-24.0818102	7.69	106.20	888.05	78.88	51.45	89.21	3.49	22.57	101.16	25.76	7.80	34.53	0.27	503.21
H16-0026	Ca-HCO3	29.7199998	-24.0951393	7.74	96.70	694.02	77.93	30.06	65.51	6.80	11.62	101.00	60.17	29.74	131.67	0.24	220.59
H16-0027	Ca-HCO3	29.7083265	-24.0973691	7.69	94.30	683.00	90.95	21.96	84.26	4.64	14.60	131.03	39.11	5.94	26.30	0.03	284.01
H16-0029	Na-HCO3	29.6769347	-24.0987590	8.50	125.70	1140.00	64.00	43.00	188.00	2.90	22.80	65.00	6.00	9.30	41.17	0.70	729.14
H16-0031	Na-HCO3	29.6208199	-24.0768104	8.30	58.40	490.00	39.00	22.00	56.00	1.00	3.60	18.00	18.00	7.80	34.53	1.50	301.17
H16-0034	Na-HCO3	29.7598808	-23.8825194	8.42	244.00	773.10	52.80	79.04	360.36	4.00	28.43	254.95	81.26	6.79	30.06	0.89	865.34
H16-0038	Na-HCO3	29.7798603	-23.8279398	8.45	140.00	980.11	55.31	35.35	186.38	4.63	28.16	201.09	37.55	5.47	24.21	1.71	433.68
H16-0040	Ca-NO3	29.6155396	-24.1095881	8.10	123.70	1101.00	161.00	60.00	52.00	4.50	13.20	139.00	65.00	84.80	375.39	0.20	243.86
H16-0043	Ca-Cl	29.6238900	-24.1163797	8.10	156.00	1024.00	143.00	61.00	67.00	2.10	14.00	208.00	132.00	22.50	99.60	0.50	310.92
H16-0046	Na-HCO3	29.5994275	-24.0851398	8.00	185.00	1382.00	63.00	52.00	268.00	5.00	16.40	167.00	18.00	1.30	5.75	1.90	802.30
H16-0049	Na-HCO3	29.5869283	-24.1020886	8.40	57.10	522.00	30.00	17.00	84.00	2.30	19.70	21.00	13.00	0.10	0.44	3.30	349.94
H16-0070	Ca-HCO3	29.5613772	-24.1312566	8.40	65.70	587.00	60.00	31.00	44.00	1.90	1.90	16.00	9.00	7.60	33.64	0.50	391.40
H16-0076	Na-HCO3	29.6188788	-23.8090486	8.00	74.60	567.00	33.00	31.00	70.00	12.40	35.00	50.00	18.00	9.01	39.89	0.30	312.14
H16-0077	Na-HCO3	29.5797067	-24.1170876	8.36	72.00	605.75	38.26	18.51	99.02	1.58	15.46	36.86	13.67	0.63	2.79	1.40	393.63
H16-0078	Na-HCO3	29.7655451	-23.6971154	7.90	147.00	1051.00	58.00	40.00	192.00	8.80	34.00	151.00	41.00	13.30	58.88	1.09	501.13
H16-0080	Na-HCO3	29.8086365	-23.8151352	8.48	126.30	983.91	43.77	29.29	198.59	0.71	25.99	151.60	30.56	4.36	19.30	1.52	508.45
H16-0084	Na-HCO3	29.7996604	-23.8239123	8.30	215.00	1519.55	79.10	41.83	321.16	3.85	21.62	360.95	40.68	1.66	7.35	2.09	662.45
H16-0085	Na-HCO3	29.8239392	-23.8017750	8.18	44.10	300.37	13.24	10.76	58.97	0.73	17.26	45.85	31.17	5.89	26.07	0.46	112.94
H16-0110	Mg-HCO3	29.6461263	-23.8730198	8.36	87.50	731.94	51.71	65.20	43.18	8.70	30.61	32.00	5.25	9.01	39.89	0.19	485.71
H16-0111	Mg-HCO3	29.6474875	-23.8723810	9.47	91.40	766.53	45.68	69.95	51.98	9.61	31.28	30.86	9.80	9.41	41.66	0.21	506.38
H16-0122	Na-HCO3	29.7055444	-23.8643250	8.40	128.70	1018.00	42.00	35.00	199.00	7.40	34.40	97.00	15.00	3.80	16.82	1.70	604.77
H16-0123	Na-HCO3	29.6969338	-23.8746042	8.40	119.40	887.00	49.00	33.00	163.00	5.70	31.00	105.00	11.00	5.30	23.46	1.50	496.26
H16-0126	Na-HCO3	29.7292686	-23.7968585	8.25	156.00	1036.36	66.63	67.06	141.47	7.92	29.47	183.67	32.08	10.69	47.33	0.55	489.55
H16-0127	Na-HCO3	29.7072146	-23.7934142	8.45	89.90	698.00	36.56	35.47	99.89	11.51	30.21	68.33	17.01	17.93	79.37	0.35	349.38
H16-0127	Na-HCO3	29.7072146	-23.7934142	8.45	89.90	698.00	36.56	35.47	99.89	11.51	30.21	68.33	17.01	17.93	79.37	0.35	349.38
H16-0129	Na-HCO3	29.7579087	-23.8021082	8.14	89.10	669.70	42.76	33.38	81.86	5.16	27.75	44.74	29.69	19.34	85.61	0.47	345.81
H16-0130	Na-HCO3	29.7509639	-23.8019971	8.40	58.20	470.00	31.00	24.00	59.00	5.60	5.70	10.00	14.00	11.20	49.58	0.40	278.00
H16-0131	Na-HCO3	29.7724948	-23.7912801	8.54	97.30	776.49	37.81	26.29	142.17	1.73	29.90	53.74	33.29	14.32	63.39	1.08	416.87
H16-0132	Na-HCO3	29.7547141	-23.7962797	8.30	103.20	870.00	46.00	45.00	130.00	5.80	6.10	54.00	20.00	15.00	66.40	0.60	502.35
H16-0133	Na-HCO3	29.7358234	-23.7729412	8.10	88.30	685.00	41.00	41.00	79.00	15.00	29.70	82.00	20.00	26.60	117.75	0.20	287.75
H16-0134	Na-HCO3	29.7341533	-23.7746111	7.80	86.80	643.00	37.00	38.00	81.00	12.00	31.20	71.00	22.00	21.10	93.41	0.20	288.97
H16-0135	Na-HCO3	29.6872400	-23.7532597	8.30	89.60	673.00	43.00	31.00	98.00	8.90	6.70	92.00	14.00	16.90	74.81	0.30	312.14
H16-0136	Mg-HCO3	29.7006600	-23.7597497	8.60	112.00	816.00	53.00	53.00	97.00	17.10	3.30	105.00	41.00	42.60	188.58	0.30	262.15
H16-0137	Na-HCO3	29.7052100	-23.7539397	7.90	85.60	650.00	37.00	37.00	79.00	12.80	13.30	66.00	18.00	32.76	145.02	0.33	254.83
H16-0141	Na-HCO3	29.7466566	-23.7696115	7.70	83.70	636.00	36.00	38.00	77.00	11.80	30.00	79.00	19.00	21.90	96.95	0.20	278.00
H16-0141	Na-HCO3	29.7466566	-23.7696115	7.70	83.70	636.00	36.00	38.00	77.00	11.80	30.00	79.00	19.00	21.90	96.95	0.20	278.00
H16-0145	Mg-HCO3	29.7911156	-23.7804408	8.53	67.50	532.52	30.70	42.02	51.04	1.79	27.46	36.56	33.65	7.99	35.37	0.16	301.08
H16-0146	Na-HCO3	29.7840209	-23.7858871	7.91	109.00	890.03	63.54	51.02	109.08	1.84	25.76	63.62	27.33	8.74	38.68	0.33	534.54

Borehole nr.	Water type	X	Y	pH	EC	TDS	Ca	Mg	Na	K	Si	Cl	SO4	N	NO3	F	HCO3
H16-0146	Na-HCO3	29.7840209	-23.7858871	7.91	109.00	890.03	63.54	51.02	109.08	1.84	25.76	63.62	27.33	8.74	38.68	0.33	534.54
H16-0147	Na-HCO3	29.7447137	-23.8084411	8.39	55.50	431.64	24.92	14.61	75.68	0.98	34.31	17.87	15.98	11.22	49.67	0.66	231.09
H16-0150	Na-HCO3	29.7891524	-23.7390567	8.20	79.80	584.00	38.00	32.00	70.00	10.50	32.80	46.00	32.00	27.72	122.71	0.22	232.89
H16-0152	Na-HCO3	29.7904379	-23.7258357	8.16	117.80	932.53	52.71	52.88	122.54	8.51	28.14	86.81	35.25	18.60	82.32	0.29	491.13
H16-0153	Na-HCO3	29.7877756	-23.7182251	8.30	108.40	810.00	51.00	44.00	112.00	8.90	29.00	88.00	45.00	21.38	94.64	0.30	367.01
H16-0154	Na-HCO3	29.7816554	-23.7260045	8.20	81.80	604.00	34.00	22.00	91.00	21.20	37.50	59.00	34.00	18.51	81.94	0.23	259.71
H16-0156	Na-HCO3	29.7774984	-23.6993364	8.10	89.50	618.00	39.00	28.00	93.00	8.00	26.50	74.00	56.00	34.68	153.52	0.27	167.04
H16-0160	Na-HCO3	29.7847155	-23.7068359	8.60	112.60	874.00	13.00	38.00	174.00	8.40	27.50	99.00	27.00	3.50	15.49	0.40	499.91
H16-0162	Na-HCO3	29.8147168	-23.7207250	7.61	100.00	805.75	41.27	40.42	124.83	5.06	28.15	81.93	18.54	16.23	71.85	0.26	421.46
H16-0164	Na-HCO3	29.8161057	-23.7286133	8.09	103.10	877.59	49.01	51.64	111.04	7.04	31.88	85.93	34.22	18.68	82.69	0.25	455.71
H16-0164	Na-HCO3	29.8161057	-23.7286133	8.09	103.10	877.59	49.01	51.64	111.04	7.04	31.88	85.93	34.22	18.68	82.69	0.25	455.71
H16-0167	Na-HCO3	29.6896800	-23.8008097	8.00	104.60	884.00	52.00	48.00	122.00	6.70	30.90	73.00	20.00	13.08	57.90	0.58	503.57
H16-0170	Mg-HCO3	29.6492655	-23.8169125	8.35	70.10	535.94	36.16	32.32	55.56	11.36	34.34	49.86	18.34	19.68	87.12	0.23	244.82
H16-0172	Na-HCO3	29.6383206	-23.8354390	8.50	79.70	631.23	28.16	39.68	80.25	9.77	34.65	42.18	22.68	18.97	83.98	0.32	324.05
H16-0174	Mg-HCO3	29.6397112	-23.8515490	8.10	144.00	1092.44	59.38	89.95	108.97	4.54	31.89	111.15	31.59	30.97	137.10	0.25	549.29
H16-0180	Mg-HCO3	29.7979722	-23.7595275	7.60	69.90	565.00	49.00	49.00	26.00	1.70	31.10	19.00	24.00	5.95	26.34	0.26	370.67
H16-0192	Na-NO3	29.7347343	-23.5005799	8.18	143.00	1016.82	81.37	45.70	134.95	12.02	36.93	143.35	49.67	71.11	314.81	1.51	233.41
H16-0192	Na-NO3	29.7347343	-23.5005799	8.18	143.00	1016.82	81.37	45.70	134.95	12.02	36.93	143.35	49.67	71.11	314.81	1.51	233.41
H16-0193	Na-HCO3	29.7267761	-23.5005199	8.55	103.30	757.00	52.49	30.27	108.99	9.61	36.46	90.85	37.16	46.70	206.71	1.63	217.98
H16-0193	Na-HCO3	29.7267761	-23.5005199	8.55	103.30	757.00	52.49	30.27	108.99	9.61	36.46	90.85	37.16	46.70	206.71	1.63	217.98
H16-0194	Na-Cl	29.6976502	-23.5127590	8.16	208.00	1280.26	110.91	60.87	170.34	18.15	33.94	226.41	79.59	79.20	350.61	1.05	262.26
H16-0194	Na-Cl	29.6976502	-23.5127590	8.16	208.00	1280.26	110.91	60.87	170.34	18.15	33.94	226.41	79.59	79.20	350.61	1.05	262.26
H16-0202	Na-HCO3	29.4816438	-24.1848628	8.10	143.00	1166.00	49.00	21.00	266.00	2.70	13.70	125.00	57.00	0.09	0.40	3.53	642.57
H16-0210	Na-HCO3	29.6186003	-23.8087786	8.10	79.50	600.00	38.00	34.00	72.00	11.60	36.30	59.00	14.00	8.60	38.07	0.30	334.09
H16-0213	Na-HCO3	29.6163802	-23.8118284	8.10	79.50	600.00	38.00	34.00	72.00	11.60	36.30	59.00	14.00	8.60	38.07	0.30	334.09
H16-0215	Mg-Cl	29.7308238	-23.4724118	8.37	373.00	2161.96	191.25	154.97	275.61	25.99	25.44	855.44	84.72	19.96	88.35	1.29	483.98
H16-0216	Na-HCO3	29.7652740	-24.0409831	8.50	111.60	920.00	52.00	41.00	153.00	1.70	16.00	110.00	17.00	0.70	3.10	0.60	541.37
H16-0219	Na-HCO3	29.7386041	-23.4529632	7.90	163.00	1142.00	84.00	64.00	169.00	10.10	31.00	232.00	57.00	3.20	14.17	1.58	512.11
H16-0219	Na-HCO3	29.7386041	-23.4529632	7.90	163.00	1142.00	84.00	64.00	169.00	10.10	31.00	232.00	57.00	3.20	14.17	1.58	512.11
H16-0220	Na-HCO3	29.7286026	-23.4783248	7.71	163.00	1083.75	73.03	45.68	170.09	15.88	27.82	230.94	47.94	19.89	88.05	2.07	409.95
H16-0220	Na-HCO3	29.7286026	-23.4783248	7.71	163.00	1083.75	73.03	45.68	170.09	15.88	27.82	230.94	47.94	19.89	88.05	2.07	409.95
H16-0221	Na-Cl	29.7283237	-23.4779615	8.42	229.00	1420.02	121.69	79.60	194.99	12.76	25.95	338.52	50.12	37.03	163.90	1.73	456.61
H16-0221	Na-Cl	29.7283237	-23.4779615	8.42	229.00	1420.02	121.69	79.60	194.99	12.76	25.95	338.52	50.12	37.03	163.90	1.73	456.61
H16-0230	Na-HCO3	29.6208200	-23.8101074	8.46	74.30	576.86	33.26	30.66	77.60	13.42	38.86	52.86	22.25	6.87	30.41	0.31	315.88
H16-0230	Na-HCO3	29.6208200	-23.8101074	8.46	74.30	576.86	33.26	30.66	77.60	13.42	38.86	52.86	22.25	6.87	30.41	0.31	315.88
H16-0242	Mg-Cl	29.6172097	-24.1154178	7.90	104.60	717.00	68.00	48.00	70.00	1.30	11.00	117.00	46.00	38.90	172.20	0.40	193.87
H16-0309	Na-HCO3	29.7895181	-23.6921158	8.41	100.81	797.76	43.95	34.72	128.11	8.46	31.86	81.31	33.91	10.25	45.37	0.44	421.35
H16-0314	Na-Cl	29.8159666	-23.8103300	8.36	170.00	1134.39	42.27	38.63	251.16	0.82	24.12	288.02	46.41	0.81	3.59	0.74	462.57
H16-0315	Na-HCO3	29.6340982	-23.8166070	8.63	84.70	698.43	21.92	28.49	128.38	9.01	34.59	45.10	23.57	8.87	39.27	0.60	401.87
H16-0316	Na-HCO3	29.6305425	-23.8396054	8.50	88.10	811.23	33.57	43.01	115.10	8.42	33.50	11.77	17.64	1.65	7.30	0.45	573.80
H16-0345	Na-HCO3	29.6250717	-23.8483548	8.34	74.70	632.47	20.46	22.12	118.42	7.80	34.53	21.27	11.54	9.79	43.34	0.66	386.74
H16-0349	Na-HCO3	29.6380426	-23.8937684	8.51	125.10	1007.19	21.21	20.94	236.37	8.04	34.40	107.09	16.74	3.97	17.57	2.33	576.73
H16-0350	Na-HCO3	29.6278234	-23.8775195	8.49	89.60	771.91	28.89	28.56	140.69	7.80	30.28	39.39	4.00	2.52	11.16	1.24	511.74
H16-0350	Na-HCO3	29.6278234	-23.8775195	8.49	89.60	771.91	28.89	28.56	140.69	7.80	30.28	39.39	4.00	2.52	11.16	1.24	511.74
H16-0372	Na-HCO3	29.7574937	-24.0429229	7.90	95.40	726.00	40.00	42.00	103.00	6.00	5.40	100.00	72.00	9.60	42.50	0.40	320.68

Borehole nr.	Water type	X	Y	pH	EC	TDS	Ca	Mg	Na	K	Si	Cl	SO4	N	NO3	F	HCO3
H16-0379	Na-HCO3	29.8232213	-23.4551632	8.59	167.00	1152.12	63.39	54.08	180.41	7.13	26.30	148.82	43.24	38.23	169.25	0.79	484.93
H16-0379	Na-HCO3	29.8232213	-23.4551632	8.59	167.00	1152.12	63.39	54.08	180.41	7.13	26.30	148.82	43.24	38.23	169.25	0.79	484.93
H16-0393	Na-HCO3	29.8165809	-23.4662924	8.13	171.00	1130.14	80.16	64.85	142.40	8.77	29.08	136.29	63.99	39.60	175.31	0.76	457.37
H16-0393	Na-HCO3	29.8165809	-23.4662924	8.13	171.00	1130.14	80.16	64.85	142.40	8.77	29.08	136.29	63.99	39.60	175.31	0.76	457.37
H16-0397	Na-HCO3	29.7652697	-23.7101700	8.35	72.70	570.76	26.69	15.80	104.22	4.64	34.41	43.76	33.04	11.74	51.97	0.44	290.08
H16-0417	Na-Cl	29.7766038	-23.8391890	8.33	512.00	335.40	142.11	68.48	848.64	6.42	20.83	1028.60	392.72	7.33	32.45	3.90	811.93
H16-0510	Na-HCO3	29.6184865	-23.8236342	8.62	68.50	546.45	26.52	31.10	75.81	9.72	39.71	38.67	15.47	3.01	13.32	0.37	335.20
H16-0510	Na-HCO3	29.6184865	-23.8236342	8.62	68.50	546.45	26.52	31.10	75.81	9.72	39.71	38.67	15.47	3.01	13.32	0.37	335.20
H16-0537	Na-HCO3	29.8249986	-23.7982197	7.97	126.70	888.76	40.48	34.42	180.42	0.87	26.49	183.08	42.91	17.26	76.41	1.55	327.48
H16-0601	Mg-Cl	29.7940123	-23.8282976	8.03	107.60	636.86	74.83	47.98	69.99	0.98	22.54	180.24	108.24	18.85	83.45	0.24	120.55
H16-0605	Na-Cl	29.7966224	-23.8262977	8.09	58.60	363.21	30.29	18.95	49.63	1.20	22.07	73.19	54.76	2.42	10.71	0.30	124.08
H16-0720	Mg-HCO3	29.8483497	-23.4611228	8.07	65.50	530.83	35.72	32.54	55.78	1.20	21.40	21.67	5.71	0.26	1.16	0.71	376.29
H16-0749	Na-HCO3	29.6988236	-23.5060450	8.29	167.00	1110.64	82.11	46.05	156.38	16.05	37.82	185.17	60.29	51.68	228.78	1.47	334.03
H16-0749	Na-HCO3	29.6988236	-23.5060450	8.29	167.00	1110.64	82.11	46.05	156.38	16.05	37.82	185.17	60.29	51.68	228.78	1.47	334.03
H16-0750	Ca-HCO3	29.6141802	-24.1129201	7.71	100.30	675.84	71.90	42.56	45.92	1.88	13.86	93.86	30.87	41.07	181.79	0.46	206.44
H16-0921	Na-HCO3	29.6944600	-23.7641997	8.38	117.60	816.63	60.00	49.27	102.03	8.39	39.62	122.68	26.73	42.29	187.23	0.29	259.90
H16-1246	Na-HCO3	29.7219375	-23.8080244	8.12	83.20	622.22	40.57	35.50	68.21	15.85	37.43	40.42	21.90	25.17	111.44	0.24	288.01
H16-1246	Na-HCO3	29.7219375	-23.8080244	8.12	83.20	622.22	40.57	35.50	68.21	15.85	37.43	40.42	21.90	25.17	111.44	0.24	288.01
H16-1246	Na-HCO3	29.7219375	-23.8080244	8.12	83.20	622.22	40.57	35.50	68.21	15.85	37.43	40.42	21.90	25.17	111.44	0.24	288.01
H26-0032	Na-Cl	28.8835777	-22.9068895	9.40	62.20	323.00	9.00	1.00	107.00	0.50	14.30	138.00	41.00	0.00	0.02	0.50	48.25
H26-0240	Mg-NO3	28.8677472	-22.9002199	7.73	620.00	3993.17	492.26	354.75	204.31	2.34	33.02	648.65	188.60	399.53	1768.64	0.29	599.22
H26-0256	Na-Cl	28.7171729	-22.8782211	9.15	31.60	172.22	2.92	1.00	54.54	0.78	16.49	55.22	8.90	0.05	0.22	0.47	87.19
H26-0460	Mg-HCO3	29.1852220	-22.9796390	8.10	96.10	798.83	77.62	61.89	40.02	1.56	40.41	48.12	3.00	19.99	0.00	0.83	477.24
H26-0461	Na-HCO3	29.1852110	-22.9796250	8.14	84.20	650.29	9.46	7.14	167.03	0.42	41.59	59.90	15.94	16.17	0.00	0.80	317.78
H26-0466	Na-HCO3	29.1847400	-22.9786100	8.15	73.70	594.66	6.52	4.78	154.66	0.41	2.14	36.20	3.00	17.84	0.00	0.52	309.05
Handpump P00	Na-HCO3	28.9753200	-23.4379300	7.96	135.00	846.00	72.00	51.80	140.00	12.50	29.70	178.50	46.90	11.90	52.70	0.20	365.20
Handpump P00	Ca-NO3	29.0187100	-23.6517200	7.90	147.00	1190.00	109.00	66.00	88.60	6.80	40.30	147.10	59.80	80.69	357.20	0.10	188.20
H-Pump 005	Mg-HCO3	28.8795600	-23.4550000	8.28	146.00	974.00	102.00	65.90	99.40	10.50	41.10	176.70	30.70	30.97	137.10	0.20	363.80
H-Unknown P0	Mg-HCO3	28.9052700	-23.4116500	8.11	93.00	632.00	58.30	56.10	57.60	5.90	50.60	91.80	18.50	14.16	62.70	0.50	258.50
Jupiter priv	Ca-NO3	29.0225800	-23.8731900	7.85	110.00	834.00	101.00	37.00	50.90	30.00	25.60	84.80	44.90	58.73	260.00	0.05	180.80

Borehole nr.	Water type	X	Y	pH	EC	TDS	Ca	Mg	Na	K	Si	Cl	SO4	N	NO3	F	HCO3
Chauke unkno	Ca-NO3	30.3758500	-23.2463800	8.48	136.00	1260.00	140.00	57.40	39.90	9.20	31.30	146.30	38.40	78.45	347.30	0.40	150.70
H04-0897	Na-Cl	29.9631380	-23.6894997	8.17	133.80	803.00	62.40	43.20	139.40	7.40	0.00	245.50	14.90	7.30	32.32	0.29	329.45
H07-0003	Ca-HCO3	30.2303892	-23.6416756	7.84	47.10	334.30	42.35	13.50	28.89	1.15	20.27	36.54	7.60	3.14	13.89	1.15	189.12
H07-0006	Mg-HCO3	30.2345252	-23.6597577	7.00	28.30	217.00	21.00	13.00	17.00	1.40	25.50	12.00	4.00	9.85	43.60	0.20	108.52
H07-0010	Na-HCO3	30.2501400	-23.6354538	7.20	25.80	200.00	11.00	10.00	23.00	4.90	24.20	9.00	7.00	3.89	17.22	0.10	118.27
H07-0012	Na-HCO3	30.2512789	-23.6628686	7.30	16.50	117.00	10.00	5.00	12.00	1.00	21.40	7.00	4.00	1.64	7.26	0.10	71.94
H07-0014	Ca-HCO3	30.2886971	-23.6380648	6.90	37.10	248.00	29.00	8.00	28.00	2.30	16.60	32.00	7.00	13.11	58.04	0.30	85.35
H07-0015	Ca-HCO3	30.3445882	-23.6203161	7.20	29.60	220.00	26.00	12.00	17.00	1.40	28.20	22.00	4.00	9.39	41.57	0.20	97.54
H07-0016	Ca-NO3	30.3490310	-23.6250380	7.97	38.30	236.86	24.38	12.19	25.27	2.52	22.47	40.78	6.00	16.24	71.89	0.20	56.26
H07-0017	Ca-HCO3	30.3493088	-23.6232881	7.70	27.30	189.16	18.72	7.47	16.51	1.60	19.44	20.48	6.00	6.05	26.78	0.20	94.35
H07-0018	Ca-HCO3	30.3606426	-23.6438979	7.36	15.70	102.56	9.20	4.95	8.67	1.33	1.90	10.00	4.00	0.08	0.35	0.14	70.04
H07-0019	Na-Cl	30.3292799	-23.6793676	7.49	37.30	210.78	21.11	7.51	26.07	2.46	19.09	39.14	4.00	12.12	53.65	0.16	58.55
H07-0020	Na-HCO3	30.3243610	-23.6695905	7.60	18.40	108.00	8.00	4.00	17.00	1.10	21.00	12.00	11.00	0.80	3.54	0.20	52.43
H07-0021	Mg-HCO3	30.3209483	-23.6722570	6.90	18.90	136.00	10.00	7.00	12.00	1.70	21.70	13.00	7.00	0.46	2.04	0.30	82.91
H07-0022	Ca-HCO3	30.3131147	-23.6792565	7.10	24.50	170.00	17.00	8.00	16.00	1.50	25.40	12.00	4.00	4.36	19.30	0.30	92.67
H07-0023	Ca-HCO3	30.2836690	-23.6837561	6.80	15.30	131.00	12.00	6.00	10.00	1.20	26.20	7.00	10.00	3.06	13.55	0.20	71.94
H07-0025	Ca-HCO3	30.3923678	-23.6271491	8.00	38.10	309.00	44.00	9.00	28.00	1.00	16.40	17.00	9.00	0.15	0.66	0.30	199.97
H07-0030	Na-HCO3	30.4127560	-23.6375373	8.20	92.20	752.00	42.00	20.00	134.00	5.40	19.90	60.00	19.00	0.10	0.44	0.80	471.87
H07-0035	Na-Cl	30.4833330	-23.6131107	8.00	196.00	1327.00	109.00	68.00	200.00	1.50	18.70	344.00	26.00	2.77	12.26	0.60	566.97
H07-0036	Na-HCO3	30.4593702	-23.6114003	8.10	115.80	887.00	69.00	39.00	128.00	2.30	24.60	137.00	29.00	14.71	65.12	0.51	418.22
H07-0037	Mg-HCO3	30.4555357	-23.5946236	7.90	65.20	513.00	35.00	41.00	38.00	0.90	28.70	42.00	28.00	0.63	2.79	0.11	324.33
H07-0043	Ca-HCO3	30.4425908	-23.5647645	8.20	85.00	629.00	62.00	33.00	66.00	1.30	21.70	87.00	18.00	4.80	21.25	0.40	338.97
H07-0044	Ca-HCO3	30.4404240	-23.5658200	7.90	88.90	674.00	71.00	39.00	66.00	1.60	16.40	98.00	16.00	0.67	2.97	0.50	379.20
H07-0047	Ca-HCO3	30.3575054	-23.5867629	8.10	71.20	492.00	52.00	31.00	44.00	0.70	32.00	64.00	11.00	8.57	37.94	0.40	252.40
H07-0051	Na-HCO3	30.3688670	-23.5843186	8.14	67.50	584.77	45.27	18.64	82.81	1.15	30.21	28.98	4.00	0.14	0.62	0.90	404.27
H07-0062	Na-Cl	30.3902890	-23.5512976	8.40	219.00	1438.00	92.00	77.00	243.00	0.90	31.70	451.00	10.00	0.05	0.22	0.80	563.32
H07-0063	Na-HCO3	30.3908401	-23.5507376	7.60	161.00	1174.00	61.00	46.00	232.00	1.00	30.70	284.00	12.00	1.41	6.24	1.00	530.40
H07-0063A	Na-HCO3	30.3907845	-23.5507376	8.20	160.00	1236.00	67.00	53.00	236.00	1.00	30.90	295.00	21.00	1.72	7.61	1.00	554.78
H07-0066	Na-HCO3	30.3877844	-23.5491544	8.20	50.70	476.00	27.00	18.00	81.00	0.50	35.30	18.00	13.00	0.18	0.80	0.70	318.24
H07-0067	Na-HCO3	30.3886198	-23.5493495	8.10	97.30	825.00	35.00	20.00	163.00	1.30	21.10	54.00	9.00	0.07	0.31	1.70	541.37
H07-0071	Na-Cl	30.4022572	-23.5518487	7.80	197.00	1198.00	107.00	71.00	171.00	2.50	22.00	388.00	21.00	1.58	6.99	0.50	431.63
H07-0079	Na-Cl	30.4103118	-23.5010466	7.83	191.00	1210.80	99.17	71.80	165.07	7.93	36.25	288.80	15.89	33.01	146.15	0.40	415.54
H07-0082	Na-HCO3	30.3877553	-23.4924361	8.17	126.20	1086.39	72.97	58.52	155.01	9.75	36.26	150.88	11.50	16.60	73.50	0.55	553.56
H07-0083	Na-HCO3	30.4564537	-23.4773539	7.86	151.00	1096.70	63.45	46.24	185.72	5.34	27.98	169.22	13.05	12.51	55.36	1.04	557.10
H07-0089	Ca-HCO3	30.3697300	-23.4736589	7.45	45.50	303.56	30.59	13.57	29.00	4.27	16.88	43.67	4.00	0.05	0.23	0.21	179.92
H07-0095	Na-HCO3	30.3461960	-23.4689932	8.02	113.10	891.04	41.15	33.34	179.19	2.23	27.99	137.09	16.38	1.95	8.62	0.70	472.29
H07-0098	Mg-Cl	30.3131963	-23.4635768	8.10	216.00	1397.00	148.00	91.00	144.00	4.60	29.10	364.00	26.00	38.46	170.25	0.40	448.70
H07-0101	Mg-Cl	30.3092539	-23.4587716	8.20	167.00	1179.00	110.00	84.00	108.00	7.50	33.90	271.00	22.00	40.57	179.60	0.50	396.27
H07-0102	Na-HCO3	30.3194466	-23.4610770	8.30	150.00	1164.00	92.00	59.00	150.00	6.90	25.90	181.00	15.00	27.28	120.76	0.50	538.93
H07-0103	Mg-HCO3	30.3497770	-23.4364997	7.70	62.90	564.00	43.00	41.00	42.00	4.40	36.50	10.00	6.00	0.38	1.68	0.40	415.78
H07-0103A	Mg-HCO3	30.3497500	-23.4365547	8.20	70.40	661.00	46.00	42.00	47.00	4.90	36.40	12.00	11.00	14.65	64.85	0.60	432.85
H07-0111	Mg-HCO3	30.3856998	-23.3923319	7.32	103.40	791.69	74.95	52.86	73.63	1.96	33.59	101.36	12.79	17.81	78.84	0.27	394.91
H07-0116	Mg-HCO3	30.4103000	-23.4340000	7.82	125.50	975.13	80.61	80.24	71.50	7.68	30.90	134.99	39.94	17.49	0.00	0.46	480.04
H07-0117	Mg-HCO3	30.4028394	-23.4200800	7.70	83.20	675.54	44.82	46.04	67.86	11.06	32.11	47.07	5.45	16.43	72.73	0.34	380.02

Borehole nr.	Water type	X	Y	pH	EC	TDS	Ca	Mg	Na	K	Si	Cl	SO4	N	NO3	F	HCO3
H07-0127	Mg-HCO3	30.4360076	-23.3907209	8.30	97.30	724.00	41.00	57.00	75.00	4.20	36.40	76.00	20.00	24.76	109.61	0.80	342.62
H07-0139	Na-HCO3	30.4595075	-23.4097197	7.50	81.10	646.30	41.05	30.13	100.66	1.80	34.69	71.20	11.18	0.64	2.82	0.54	386.82
H07-0142	Na-Cl	30.5209831	-23.4280241	7.70	284.00	1784.04	136.42	111.62	251.87	1.12	31.52	488.35	43.10	49.02	217.01	0.47	533.81
H07-0148	Na-Cl	30.5559011	-23.4344681	7.98	521.00	3131.42	294.59	171.21	530.02	5.02	22.95	1492.23	26.28	5.11	22.63	0.33	589.04
H07-0149	Na-HCO3	30.5579012	-23.4284686	8.22	166.00	1143.92	83.26	68.35	153.42	3.14	20.09	196.70	27.92	22.80	100.94	0.50	507.35
H07-0153	Mg-Cl	30.5546233	-23.4308850	7.80	250.00	1598.22	142.38	111.78	182.21	3.44	34.42	407.19	43.97	34.47	152.58	0.50	554.05
H07-0158	Na-HCO3	30.6071256	-23.4167472	7.80	123.10	1075.31	85.25	64.26	124.12	7.56	33.17	165.94	19.34	27.77	122.93	0.50	485.29
H07-0159	Mg-HCO3	30.6087923	-23.4159417	8.25	188.00	1225.51	93.18	74.92	134.63	9.40	26.57	197.70	33.45	46.78	207.09	0.48	474.42
H07-0169	Na-HCO3	30.4557036	-23.5322390	8.20	126.20	1007.00	61.00	49.00	151.00	3.50	26.20	116.00	17.00	11.41	50.51	0.70	558.44
H07-0173	Ca-HCO3	30.4950000	-23.5555275	8.27	122.50	857.79	91.65	50.99	78.63	1.68	30.83	146.98	55.21	35.49	157.11	0.51	274.88
H07-0174	Na-Cl	30.5188446	-23.5811802	8.27	269.00	1641.75	120.15	100.35	249.29	6.81	29.63	497.72	43.60	35.26	156.09	0.59	467.00
H07-0175	Na-HCO3	30.4977605	-23.5742918	8.30	117.60	920.00	59.00	49.00	122.00	2.40	26.80	133.00	12.00	13.36	59.14	0.50	484.06
H07-0177	Ca-HCO3	30.5386508	-23.5967347	7.59	79.10	640.35	70.86	30.62	54.60	3.19	27.19	50.23	24.37	1.90	8.40	0.45	397.31
H07-0180	Na-Cl	30.5409286	-23.6050120	7.80	409.00	204.00	110.00	85.00	180.00	3.40	31.30	358.00	37.00	10.37	45.91	1.00	498.69
H07-0182	Na-Cl	30.5786521	-23.5870688	8.20	254.00	1788.00	142.00	105.00	261.00	6.80	30.80	581.00	12.00	10.73	47.50	0.50	632.82
H07-0183	Na-Cl	30.5780680	-23.5865655	8.00	272.00	1723.00	124.00	95.00	283.00	6.30	4.20	540.00	38.00	17.84	78.97	0.51	557.22
H07-0184	Mg-HCO3	30.5856800	-23.6283160	7.85	187.00	1162.97	121.39	74.58	109.99	4.74	24.90	235.39	22.21	33.93	150.20	0.55	443.76
H07-0185	Mg-HCO3	30.5957637	-23.6345934	8.00	172.00	1223.00	107.00	85.00	128.00	3.60	39.10	221.00	19.00	26.91	119.13	1.00	541.37
H07-0185A	Na-HCO3	30.5957915	-23.6345656	7.90	125.80	1009.00	72.00	53.00	131.00	6.90	31.50	97.00	14.00	7.62	33.73	0.70	601.11
H07-0186	Mg-HCO3	30.5957915	-23.6345656	8.10	169.00	1193.00	116.00	73.00	119.00	4.80	32.20	220.00	19.00	24.70	109.34	0.97	531.61
H07-0187	Na-HCO3	30.5964859	-23.6340656	7.90	142.00	1077.00	72.00	59.00	150.00	7.00	27.60	137.00	28.00	7.18	31.78	1.40	591.36
H07-0191	Na-HCO3	30.5206218	-23.5267673	8.09	124.30	936.63	52.52	43.25	155.45	2.32	19.62	121.38	10.04	23.25	102.92	0.64	447.87
H07-0198	Na-HCO3	30.5172220	-23.4600000	8.07	122.00	1011.00	48.90	48.90	155.60	2.85	34.31	77.60	20.60	7.59	0.00	0.94	621.84
H07-0200	Na-HCO3	30.5192893	-23.4662992	7.86	145.00	1136.39	80.39	63.74	128.83	6.17	34.69	116.13	44.86	10.25	45.37	0.49	650.13
H07-0203	Mg-HCO3	30.5514292	-23.4868534	8.33	97.20	286.83	62.38	47.79	69.81	5.75	37.58	70.68	13.58	10.29	45.55	0.44	470.71
H07-0204	Na-HCO3	30.5568461	-23.4667992	7.90	157.00	1097.00	72.00	64.00	156.00	8.20	33.00	208.00	19.00	12.95	57.33	0.15	513.33
H07-0231	Mg-HCO3	30.5463450	-23.5248230	7.30	105.20	785.00	72.00	58.00	63.00	0.90	36.50	134.00	9.00	13.96	61.80	0.40	386.52
H07-0233	Mg-HCO3	30.4995600	-23.5019300	7.81	84.70	685.52	63.24	41.60	67.86	1.58	32.26	58.45	21.92	3.22	0.00	0.44	416.08
H07-0246	Ca-NO3	30.3704223	-23.7323918	7.90	95.40	667.82	74.15	40.59	45.87	1.41	25.68	90.65	4.00	49.76	220.28	0.21	192.28
H07-0264	Na-HCO3	30.3159739	-23.6105112	8.10	39.10	312.00	13.00	6.00	64.00	0.40	19.30	35.00	16.00	0.04	0.18	0.50	176.80
H07-0267	Ca-HCO3	30.2803610	-23.6359816	8.24	34.00	249.95	34.34	6.27	19.35	0.77	8.49	11.69	4.00	0.06	0.25	1.22	173.91
H07-0267A	Na-HCO3	30.2805546	-23.6357316	7.40	16.80	127.00	11.00	4.00	15.00	1.10	28.30	4.00	5.00	2.04	9.03	0.30	78.04
H07-0268	Na-HCO3	30.3158072	-23.6113722	8.10	30.20	244.00	21.00	10.00	33.00	2.10	14.60	17.00	10.00	0.19	0.84	1.50	148.75
H07-0288	Mg-HCO3	30.3953940	-23.7000052	7.52	73.30	524.14	47.50	32.47	48.36	1.86	25.34	63.93	16.09	7.67	33.96	0.30	279.63
H07-0293	Mg-HCO3	30.3888937	-23.7078380	7.64	83.80	597.85	46.67	45.27	49.03	3.85	22.83	87.21	17.81	6.49	28.71	0.28	318.96
H07-0300	Ca-NO3	30.4971215	-23.6135946	8.00	166.00	1233.00	142.00	79.00	101.00	3.40	26.10	192.00	58.00	86.98	385.04	0.40	271.90
H07-0313	Na-HCO3	30.4734160	-23.6146657	8.30	121.10	1018.00	45.00	27.00	201.00	2.70	22.20	104.00	15.00	5.17	22.89	0.68	599.90
H07-0314	Ca-HCO3	30.4602025	-23.6157611	7.70	116.40	855.00	89.00	50.00	82.00	4.40	24.10	157.00	30.00	14.10	62.42	0.44	380.42
H07-0315	Mg-Cl	30.4599247	-23.6159833	7.90	152.00	999.00	100.00	64.00	92.00	4.50	26.90	185.00	48.00	51.75	229.09	0.41	278.00
H07-0319	Mg-HCO3	30.3943939	-23.7327252	7.73	49.70	356.22	30.89	22.51	27.30	2.02	28.03	28.27	5.15	2.10	9.30	0.28	229.75
H07-0326	Na-HCO3	30.4114780	-23.7496129	7.93	70.40	533.84	43.61	26.05	61.92	0.89	26.92	52.30	4.00	0.04	0.18	0.73	346.16
H07-0352	Na-HCO3	30.5056488	-23.6320656	8.70	108.60	990.00	44.00	37.00	198.00	1.50	21.20	117.00	54.00	3.74	16.56	0.78	521.86
H07-0359	Mg-HCO3	30.5059551	-23.6430371	8.30	58.00	465.00	32.00	39.00	35.00	3.50	29.10	20.00	6.00	6.89	30.50	0.32	298.73
H07-0371	Na-HCO3	30.4857877	-23.6610914	7.10	60.00	453.67	17.79	23.32	62.69	10.62	39.59	35.69	15.85	12.43	55.03	0.36	232.01

Borehole nr.	Water type	X	Y	pH	EC	TDS	Ca	Mg	Na	K	Si	Cl	SO4	N	NO3	F	HCO3
H07-0379	Mg-HCO3	30.3321712	-23.5820409	8.50	73.40	256.00	43.00	48.00	34.00	1.00	36.00	50.00	13.00	8.51	37.67	0.80	312.14
H07-0380	Mg-HCO3	30.2288937	-23.6387900	7.60	36.70	284.00	28.00	17.00	23.00	1.60	33.90	22.00	6.00	5.06	22.40	0.20	163.39
H07-0383	Na-HCO3	30.4197288	-23.5154601	8.42	125.60	1027.28	46.58	27.22	204.35	2.73	22.37	116.09	15.33	7.36	32.58	0.68	581.61
H07-0386	Mg-Cl	30.4127854	-23.5428771	7.70	193.00	1341.00	86.00	136.00	131.00	1.90	36.60	366.00	16.00	19.46	86.15	0.30	516.98
H07-0387	Mg-HCO3	30.3464720	-23.5738047	7.60	61.40	459.42	35.98	36.38	36.20	0.71	34.75	41.64	4.00	3.52	15.58	0.28	290.44
H07-0393	Mg-HCO3	30.4335357	-23.7150042	7.83	62.70	503.31	43.37	30.80	41.14	2.79	31.94	30.79	7.24	4.70	20.81	0.32	325.88
H07-0395	Na-HCO3	30.4417500	-23.7178877	8.00	72.30	606.00	30.00	24.00	97.00	0.80	20.60	23.00	8.00	0.05	0.22	0.60	423.10
H07-0400	Mg-HCO3	30.2177788	-23.6335117	8.10	51.50	379.00	29.00	37.00	31.00	0.80	34.70	33.00	5.00	2.88	12.75	0.30	236.54
H07-0401	Mg-HCO3	30.2177808	-23.6337867	7.60	49.30	367.00	32.00	26.00	30.00	1.10	22.90	35.00	9.00	2.55	11.29	0.30	221.91
H07-0404	Na-HCO3	30.3334487	-23.7118654	7.80	51.50	380.37	14.80	10.23	79.86	2.29	19.98	49.06	4.00	0.08	0.34	0.36	221.33
H07-0405	Mg-HCO3	30.3329487	-23.7142263	8.30	45.90	367.00	29.00	21.00	32.00	2.00	21.80	18.00	16.00	0.05	0.22	0.40	248.74
H07-0408	Mg-Cl	30.3649225	-23.5532096	7.37	120.10	833.90	74.02	61.89	77.34	4.08	35.21	144.67	27.40	52.76	233.56	0.28	210.52
H07-0410	Na-Cl	30.5919605	-23.6179534	8.10	210.00	1301.00	52.00	72.00	249.00	6.50	14.20	434.00	22.00	0.90	3.98	0.33	460.90
H07-0411	Ca-Cl	30.5900170	-23.6254569	7.90	218.00	1468.00	144.00	72.00	161.00	7.00	30.90	271.00	56.00	83.54	369.81	0.47	386.52
H07-0413	Mg-Cl	30.5914056	-23.6485114	7.83	258.00	1598.83	146.56	108.47	180.22	1.84	28.26	438.12	32.06	28.88	127.85	0.88	562.22
H07-0414	Na-Cl	30.5336212	-23.6198983	8.00	458.00	2782.00	246.00	165.00	466.00	6.10	19.70	1218.00	32.90	1.34	5.95	0.56	649.89
H07-0415	Na-Cl	30.5330646	-23.6193459	8.40	672.00	4401.00	120.00	127.00	1192.00	9.60	21.50	1857.00	42.00	15.30	67.73	0.65	983.98
H07-0416	Mg-Cl	30.5389034	-23.6265627	8.33	270.00	1660.08	164.08	105.04	191.72	8.09	28.60	510.29	24.70	30.05	133.03	0.54	522.47
H07-0417	Mg-HCO3	30.4583145	-23.6598969	8.00	50.40	438.00	27.00	28.00	46.00	7.50	29.70	23.00	12.00	6.00	26.56	0.50	268.25
H07-0418	Na-HCO3	30.2988906	-23.6987873	7.90	34.10	261.00	13.00	2.00	56.00	2.10	14.00	23.00	11.00	0.10	0.44	4.30	149.97
H07-0419	Na-HCO3	30.4218132	-23.6797011	7.84	88.80	614.01	43.34	35.11	77.48	5.83	22.48	100.32	16.14	16.74	74.10	0.38	261.03
H07-0422	Ca-HCO3	30.3510607	-23.6238992	7.90	22.80	168.00	18.00	6.00	19.00	1.70	11.70	16.00	8.00	0.77	3.41	0.20	95.11
H07-0423	Na-HCO3	30.4655926	-23.6505365	8.41	84.00	627.70	36.46	17.50	122.35	3.69	24.22	73.18	7.02	0.09	0.40	1.22	365.80
H07-0432	Na-HCO3	30.3226704	-23.6040949	7.80	46.10	393.00	35.00	12.00	57.00	0.70	22.60	20.00	5.00	1.32	5.84	1.80	254.83
H07-0433	Ca-HCO3	30.2626683	-23.6590078	7.20	16.10	117.00	11.00	5.00	10.00	1.10	16.50	10.00	4.00	1.69	7.48	0.20	68.28
H07-0442	Mg-HCO3	30.4750110	-23.5899051	6.56	129.00	796.00	74.80	51.30	91.50	2.00	0.00	161.50	45.30	47.20	208.94	0.40	331.77
H07-0443	Ca-HCO3	30.4753430	-23.5919294	6.63	98.10	623.00	68.90	41.70	68.50	2.00	0.00	112.50	31.70	28.50	126.16	0.45	325.43
H07-0444	Mg-HCO3	30.4412500	-23.5651377	7.20	91.50	553.00	42.90	52.20	88.50	3.00	0.00	95.00	8.30	0.16	0.71	0.48	463.33
H07-0445	Na-HCO3	30.4705650	-23.6456757	7.10	60.50	367.00	32.30	25.80	88.80	3.00	0.00	44.00	7.30	11.50	50.91	0.69	360.43
H07-0446	Na-HCO3	30.4723150	-23.6477867	7.10	86.20	522.00	50.40	40.50	87.50	5.00	0.00	80.50	6.30	0.00	0.00	0.57	470.04
H07-0448	Mg-HCO3	30.5068333	-23.4896108	6.92	93.50	565.00	67.80	46.60	64.00	10.00	0.00	66.00	13.00	7.95	35.19	0.51	488.57
H07-0451	Na-HCO3	30.4165340	-23.6291212	8.00	111.70	857.00	79.00	41.00	118.00	1.30	23.60	167.00	11.00	2.41	10.67	0.90	429.19
H07-0454	Na-HCO3	30.3250000	-23.4911110	8.15	204.00	1312.05	45.86	61.45	309.43	0.99	9.04	250.79	17.73	8.58	0.00	1.29	586.48
H07-0455	Na-HCO3	30.3450500	-23.4848600	8.34	151.00	997.67	66.32	56.68	160.22	0.66	24.44	240.17	47.64	0.48	0.00	0.65	423.13
H07-0458	Mg-HCO3	30.3483200	-23.4350000	7.52	70.10	568.18	45.39	44.39	41.62	4.16	36.48	41.92	16.21	0.45	0.00	0.38	372.07
H07-0460	Na-HCO3	30.4817598	-23.6374263	7.80	92.10	784.00	55.00	37.00	114.00	3.50	22.30	106.00	12.00	3.18	14.08	0.60	441.39
H07-0461	Na-HCO3	30.3395606	-23.4544108	8.00	91.90	656.00	53.00	35.00	84.00	9.80	36.40	123.00	29.00	5.12	22.67	0.30	299.95
H07-0462	Mg-Cl	30.3083352	-23.4568565	8.40	210.00	1331.00	136.00	88.00	140.00	4.70	29.80	347.00	28.00	38.85	171.98	0.40	415.78
H07-0464	Ca-HCO3	30.3175042	-23.4576050	8.42	126.00	970.00	97.45	53.79	96.75	5.93	25.59	117.33	16.62	24.84	109.95	0.49	471.49
H07-0465	Na-Cl	30.5411780	-23.5686811	8.13	121.70	811.66	66.29	47.09	118.73	2.13	22.17	210.18	17.56	11.50	50.91	0.53	298.11
H07-0467	Na-Cl	30.5711258	-23.5765682	8.10	458.00	2832.00	179.00	166.00	536.00	3.20	23.90	1242.00	32.00	0.41	1.81	0.64	671.83
H07-0471	Mg-Cl	30.5925156	-23.6190633	7.90	190.00	1143.44	115.21	76.36	105.66	3.03	23.38	266.95	19.01	30.83	136.48	0.39	420.17
H07-0474	Na-HCO3	30.4438688	-23.4737986	7.63	182.00	1327.27	96.78	73.93	176.04	8.09	37.07	194.02	31.55	18.11	80.18	0.62	665.98
H07-0490	Na-HCO3	30.3686983	-23.7422245	8.25	55.50	425.12	17.77	13.24	78.96	1.82	22.55	23.61	4.00	0.04	0.18	0.73	286.69

Borehole nr.	Water type	X	Y	pH	EC	TDS	Ca	Mg	Na	K	Si	Cl	SO4	N	NO3	F	HCO3
H07-0502	Na-HCO3	30.3717282	-23.5914848	7.53	58.60	375.38	31.67	10.08	67.02	0.49	17.11	77.73	30.86	0.08	0.35	0.33	155.91
H07-0512	Mg-HCO3	30.5108611	-23.4955497	7.57	119.00	879.64	91.07	66.85	43.20	0.74	36.15	81.69	61.24	31.15	137.89	0.57	396.15
H07-0513	Mg-HCO3	30.5800129	-23.4899121	7.97	206.00	1495.58	107.92	100.67	137.22	1.52	33.02	160.12	50.76	81.66	361.49	0.62	575.14
H07-0516	Mg-HCO3	30.5814052	-23.4932419	8.35	141.00	926.27	50.71	70.86	113.82	1.72	6.75	212.09	30.84	0.12	0.53	0.63	443.58
H07-0522	Na-Cl	30.4641700	-23.4979600	7.99	506.00	3404.58	262.93	243.04	496.31	14.41	19.96	1202.03	47.51	69.99	0.00	0.51	827.90
H07-0526	Mg-HCO3	30.3391900	-23.4477100	8.05	102.10	774.41	57.02	50.25	92.12	1.97	39.78	91.77	32.83	8.69	0.00	0.86	409.06
H07-0530	Na-HCO3	30.1530500	-23.4266700	7.96	178.00	1307.44	90.93	70.43	194.17	2.72	24.67	216.27	25.58	20.61	0.00	0.56	615.50
H07-0539	Mg-HCO3	30.4287017	-23.3843603	8.29	90.20	695.70	57.79	51.50	60.29	3.09	37.42	65.13	14.35	25.96	114.91	0.53	328.04
H07-0542	Na-HCO3	30.3553100	-23.5158700	7.96	87.20	724.57	35.20	28.42	123.72	5.94	37.09	44.64	9.00	3.74	0.00	0.63	460.37
H07-0545	Na-HCO3	30.3551166	-23.5159900	8.10	96.50	823.00	35.00	29.00	154.00	6.50	31.50	57.00	12.00	3.87	17.13	0.80	512.11
H07-0548	Mg-HCO3	30.4536482	-23.4316904	8.00	112.50	857.00	55.00	71.00	63.00	19.60	34.70	101.00	29.00	34.05	150.73	0.40	369.45
H07-0554	Ca-HCO3	30.2955306	-23.6819785	7.30	20.90	145.00	14.00	5.00	16.00	2.40	24.40	9.00	4.00	3.93	17.40	0.20	80.47
H07-0558	Na-HCO3	30.3548943	-23.5790134	8.00	53.80	414.00	24.00	16.00	76.00	0.70	29.40	57.00	26.00	1.42	6.29	0.50	207.28
H07-0560	Na-HCO3	30.3558943	-23.5783190	8.40	55.40	468.00	20.00	10.00	100.00	0.50	27.00	25.00	8.00	0.04	0.18	2.10	302.39
H07-0561	Na-HCO3	30.3685614	-23.5847075	8.00	65.70	551.00	48.00	22.00	70.00	1.10	32.70	34.00	6.00	1.87	8.28	1.00	359.69
H07-0562	Ca-HCO3	30.2369462	-23.6596225	7.00	27.30	216.00	22.00	9.00	16.00	1.50	20.10	6.00	4.00	5.57	24.66	0.30	134.12
H07-0563	Mg-HCO3	30.2925861	-23.6837006	7.10	21.10	155.00	13.00	8.00	15.00	2.40	25.20	11.00	4.00	4.07	18.02	0.30	86.57
H07-0566	Mg-HCO3	30.2502834	-23.6385066	7.10	13.60	95.00	6.00	6.00	9.00	0.70	22.60	5.00	6.00	3.39	15.01	0.10	47.55
H07-0567	Ca-HCO3	30.2408358	-23.6446182	6.80	20.20	151.00	15.00	5.00	17.00	2.40	25.70	14.00	4.00	6.70	29.66	0.10	65.84
H07-0569	Na-HCO3	30.5105600	-23.5010200	7.78	90.00	664.27	60.25	37.29	77.64	1.80	20.75	103.06	30.83	1.30	0.00	0.52	347.02
H07-0580	Na-HCO3	30.4234801	-23.5978456	8.10	63.00	469.00	38.00	18.00	66.00	3.10	26.40	58.00	7.00	3.04	13.46	0.40	265.81
H07-0582	Na-HCO3	30.4231745	-23.5877074	8.20	72.80	584.00	51.00	17.00	84.00	1.50	24.10	35.00	7.00	0.04	0.18	0.50	388.96
H07-0586	Na-HCO3	30.3679160	-23.4627497	8.09	151.00	1066.16	71.60	55.62	151.41	8.54	30.54	171.45	14.01	35.29	156.22	0.47	436.66
H07-0601	Na-HCO3	30.5303451	-23.5267395	8.42	150.00	1125.97	51.34	56.47	186.06	2.03	30.30	141.05	7.95	11.98	53.03	0.75	627.09
H07-0605	Na-HCO3	30.3843402	-23.4102751	8.20	92.70	708.00	53.00	40.00	79.00	7.50	27.40	66.00	9.00	24.39	107.97	0.30	345.06
H07-0617	Mg-HCO3	30.6562383	-23.4399402	7.80	143.00	1141.00	61.00	106.00	85.00	6.00	35.10	101.00	16.00	13.37	59.19	0.30	707.19
H07-0621	Mg-HCO3	30.4213890	-23.4105560	8.01	173.00	1120.27	91.75	81.78	112.74	12.00	28.01	246.54	26.52	7.59	0.00	0.35	514.91
H07-0627	Na-HCO3	30.4422289	-23.3940785	7.74	106.40	823.62	52.71	52.06	105.56	3.56	27.96	115.79	24.42	1.06	4.69	0.79	463.94
H07-0633	Ca-HCO3	30.2970007	-23.6318430	7.70	33.50	212.66	21.51	8.74	23.54	0.79	25.45	34.90	6.00	4.89	21.63	0.21	97.48
H07-0634	Na-HCO3	30.3893661	-23.6393982	7.85	17.90	120.18	8.27	3.51	17.78	2.27	5.12	18.13	6.00	0.11	0.49	0.20	66.14
H07-0636	Mg-HCO3	30.3361991	-23.5810966	8.10	62.60	469.00	40.00	32.00	44.00	2.00	25.80	46.00	14.00	0.23	1.02	0.80	287.75
H07-0654	Ca-HCO3	30.2997809	-23.6233992	7.80	28.70	253.00	26.00	13.00	20.00	0.90	24.40	10.00	4.00	0.30	1.33	0.40	178.02
H07-0659	Mg-HCO3	30.4315916	-23.5364609	7.87	82.80	596.51	48.45	36.79	63.13	1.59	26.38	85.59	7.31	7.83	34.68	0.35	319.14
H07-0662	Na-Cl	30.2923083	-23.6950054	7.50	50.70	355.00	32.00	16.00	45.00	5.90	20.80	96.00	12.00	0.05	0.22	0.40	146.32
H07-0668	Mg-Cl	30.5401231	-23.5570986	8.04	166.00	1068.33	101.35	80.66	101.04	2.84	30.32	254.94	33.21	37.00	163.79	0.47	329.88
H07-0670	Na-Cl	30.5443732	-23.5683478	8.70	265.00	126.50	53.00	46.00	161.00	3.40	20.10	202.00	59.00	8.16	36.12	0.60	323.11
H07-0674	Mg-HCO3	30.5200113	-23.5890686	7.72	221.00	1478.43	89.32	116.06	176.39	5.10	28.52	275.18	56.29	27.18	120.31	0.68	638.91
H07-0675	Mg-HCO3	30.5179001	-23.5886241	8.27	178.00	1194.54	76.41	86.75	142.41	4.67	31.63	249.49	38.02	17.75	78.56	0.58	517.59
H07-0676	Na-Cl	30.4885379	-23.6209274	7.60	19.00	4826.00	313.00	289.00	859.00	4.20	24.60	1830.00	127.00	153.74	680.58	0.60	721.83
H07-0677	Na-HCO3	30.4960381	-23.6179277	8.20	146.00	1056.00	92.00	42.00	163.00	3.10	21.60	175.00	52.00	22.73	100.62	0.60	429.19
H07-0683	Mg-HCO3	30.2941696	-23.6100945	7.56	31.20	227.39	19.01	16.51	15.96	1.19	27.68	18.66	4.00	6.36	28.13	0.21	125.50
H07-0684	Mg-HCO3	30.2922263	-23.6087919	7.80	26.00	192.00	12.00	14.00	17.00	1.10	32.90	9.00	4.00	3.04	13.46	0.20	123.15
H07-0685	Mg-HCO3	30.2871138	-23.6133165	7.30	25.40	183.00	17.00	12.00	17.00	0.40	26.30	16.00	7.00	1.14	5.05	0.20	108.52
H07-0685	Mg-HCO3	30.2871138	-23.6133165	7.56	27.20	199.43	17.06	13.04	15.16	0.66	26.89	14.78	4.00	0.73	3.21	0.31	133.15

Borehole nr.	Water type	X	Y	pH	EC	TDS	Ca	Mg	Na	K	Si	Cl	SO4	N	NO3	F	HCO3
H07-0691	Na-HCO3	30.6384167	-23.5654441	7.95	25.50	150.63	12.89	7.06	18.11	2.98	1.73	31.75	4.00	0.06	0.26	0.18	75.34
H07-0698	Mg-HCO3	30.3951181	-23.5346832	7.59	112.10	844.57	70.03	60.16	78.81	6.83	27.69	135.48	6.14	18.25	80.79	0.39	405.83
H07-0704	Mg-HCO3	30.3844486	-23.4201866	8.10	84.90	677.00	51.00	53.00	45.00	14.50	34.10	53.00	15.00	30.89	136.74	0.50	309.70
H07-0705	Mg-HCO3	30.3358640	-23.4963802	8.30	100.90	756.00	54.00	52.00	79.00	3.80	26.40	102.00	19.00	25.69	113.72	0.50	332.87
H07-0705	Mg-HCO3	30.3358640	-23.4963802	8.25	159.00	1072.93	92.46	85.90	72.43	4.16	37.57	156.19	42.21	47.56	210.53	0.47	408.48
H07-0710	Na-Cl	30.4763611	-23.4632497	7.87	302.00	2193.34	147.39	67.38	424.07	5.84	24.97	423.66	106.48	82.15	363.64	0.59	654.15
H07-0724	Mg-Cl	30.4026100	-23.5286300	8.23	255.00	1555.60	143.72	103.13	192.78	5.84	26.53	437.24	28.93	37.79	0.00	0.40	476.21
H07-0728	Na-HCO3	30.3702500	-23.4739900	7.75	183.00	1160.18	98.98	70.05	160.88	2.76	10.90	287.50	12.62	0.04	0.00	0.34	526.74
H07-0729	Na-HCO3	30.2864748	-23.6327874	7.90	29.80	206.00	19.00	8.00	24.00	0.70	25.30	12.00	6.00	0.98	4.34	0.50	131.68
H07-0735	Ca-Cl	30.4959166	-23.5575267	7.81	189.00	1281.53	130.86	68.83	149.51	2.01	28.70	240.51	72.56	50.65	224.22	0.54	392.38
H07-0739	Na-Cl	30.4979722	-23.5583886	7.84	192.00	1285.32	113.20	68.08	178.01	1.04	26.35	261.30	36.12	42.34	187.43	0.59	437.90
H07-0745	Mg-HCO3	30.3962000	-23.5357100	8.08	145.00	1005.36	71.24	72.29	110.30	5.89	31.47	156.56	20.85	18.77	0.00	0.68	484.40
H07-0748	Na-HCO3	30.4355918	-23.5005745	8.30	155.00	1145.00	78.00	64.00	145.00	5.50	33.40	143.00	7.00	17.53	77.60	0.50	624.28
H07-0750	Mg-Cl	30.4361196	-23.5213231	8.10	289.00	1780.00	141.00	122.00	219.00	13.90	32.90	411.00	50.00	114.68	507.67	0.40	314.58
H07-0754	Mg-HCO3	30.2708883	-23.6477308	7.54	20.70	139.76	11.50	7.44	11.89	0.61	23.57	13.68	7.55	1.26	5.58	0.14	81.17
H07-0757	Na-HCO3	30.3715060	-23.5863185	7.70	76.20	596.00	62.00	24.00	74.00	1.70	34.90	75.00	9.00	0.61	2.70	0.70	347.50
H07-0760	Mg-HCO3	30.3764506	-23.5928736	7.81	64.50	485.02	45.20	27.77	50.13	0.81	33.28	60.43	15.20	4.11	18.21	0.42	266.76
H07-0761	Ca-HCO3	30.3888987	-23.6443424	8.10	41.80	335.00	43.00	10.00	32.00	1.40	26.70	13.00	5.00	0.34	1.51	0.30	230.45
H07-0767	Mg-HCO3	30.2816670	-23.6355560	7.77	27.70	182.63	16.76	13.55	10.94	1.62	26.04	11.23	4.48	4.50	0.00	0.36	103.69
H07-0780	Na-NO3	30.2302825	-23.6579500	6.90	30.60	221.00	19.00	8.00	25.00	1.60	26.60	21.00	4.00	16.54	73.22	0.20	71.94
H07-0781	Ca-NO3	30.2311670	-23.6573967	6.87	33.20	207.15	20.36	8.25	21.28	1.12	27.64	23.98	6.00	17.35	76.79	0.20	52.16
H07-0783	Ca-HCO3	30.2316625	-23.6632259	7.20	24.90	189.00	19.00	8.00	11.00	2.80	20.60	6.00	5.00	0.98	4.34	0.20	132.90
H07-0790	Ca-HCO3	30.4119505	-23.6338431	7.80	101.50	790.00	99.00	27.00	79.00	3.10	19.10	92.00	43.00	1.26	5.58	0.50	440.17
H07-0797	Na-HCO3	30.3771700	-23.5567900	8.22	51.20	431.22	25.69	16.05	69.69	0.43	30.51	30.68	8.49	0.04	0.00	0.93	279.00
H07-0798	Ca-HCO3	30.2830858	-23.6372871	7.70	32.80	245.00	26.00	12.00	17.00	0.60	24.30	12.00	16.00	0.09	0.40	0.30	167.04
H07-0799	Mg-HCO3	30.3752006	-23.5411272	7.30	88.00	623.00	51.00	41.00	62.00	4.30	37.50	94.00	10.00	27.40	121.29	0.30	241.42
H07-0801	Mg-HCO3	30.5060942	-23.5320447	8.24	97.40	753.17	62.34	53.77	64.32	2.05	26.98	68.12	13.78	12.38	54.80	0.54	433.38
H07-0806	Ca-HCO3	30.4027575	-23.4218299	7.70	20.40	136.61	18.60	4.54	5.30	2.91	4.25	11.97	4.00	0.19	0.83	0.21	89.97
H07-0810	Na-Cl	30.5340500	-23.6249397	7.65	190.00	1166.05	59.89	42.36	211.41	10.25	28.40	226.00	24.39	49.96	221.16	0.53	369.98
H07-0819	Na-HCO3	30.4758418	-23.7256980	8.43	102.10	802.51	40.01	46.29	103.42	7.58	35.43	81.54	15.80	14.52	64.27	0.52	443.06
H07-0819	Na-HCO3	30.3685200	-23.7249700	8.43	102.10	802.51	40.01	46.29	103.42	7.58	35.43	81.54	15.80	14.52	0.00	0.52	443.06
H07-0827	Mg-HCO3	30.4288900	-23.5268400	8.00	103.10	789.53	65.85	53.91	77.58	1.13	32.08	107.91	9.59	5.39	0.00	0.43	449.23
H07-0831	Mg-HCO3	30.4464535	-23.4088864	8.40	123.00	1040.00	67.00	72.00	113.00	3.70	27.70	106.00	9.00	0.10	0.44	0.54	669.40
H07-0831A	Mg-HCO3	30.4464535	-23.4089142	8.30	145.00	1070.00	67.00	82.00	125.00	4.00	28.50	158.00	12.00	0.04	0.18	0.60	621.84
H07-0834	Na-HCO3	30.3792284	-23.6177886	7.62	18.60	126.59	6.70	2.74	23.19	1.09	18.18	20.73	6.00	0.11	0.49	0.22	68.55
H07-0835	Na-HCO3	30.3779444	-23.6159719	7.55	28.50	216.71	10.98	6.40	38.08	0.71	27.27	22.34	4.00	0.05	0.20	0.27	135.67
H07-0836	Ca-HCO3	30.3658353	-23.6196195	7.30	20.70	151.00	16.00	4.00	14.00	2.00	18.70	8.00	9.00	4.87	21.56	0.50	75.60
H07-0838	Ca-HCO3	30.3951179	-23.6256214	7.70	65.10	495.00	60.00	26.00	41.00	1.10	21.30	65.00	8.00	26.63	117.89	0.30	175.58
H07-0839	Mg-Cl	30.3962500	-23.6202217	8.42	109.80	749.17	71.82	49.86	85.71	1.44	19.00	181.35	19.09	19.85	87.89	0.47	251.51
H07-0841	Mg-Cl	30.3332826	-23.4576884	7.85	413.00	2500.40	287.11	181.94	241.41	11.64	31.01	891.68	44.09	81.55	361.01	0.34	481.05
H07-0845	Na-HCO3	30.3865300	-23.4726100	8.22	149.00	1087.64	61.67	42.95	187.62	3.39	32.29	151.55	9.00	3.90	0.00	0.66	613.31
H07-0848	Mg-HCO3	30.4295073	-23.3848325	7.76	97.50	719.11	61.10	53.69	54.12	4.37	37.78	77.77	20.87	30.86	136.59	0.53	310.01
H07-0861	Mg-HCO3	30.3809480	-23.4202188	8.09	95.30	771.79	65.39	65.49	41.19	18.45	36.51	81.71	22.68	30.14	133.43	0.41	342.96
H07-0865	Mg-Cl	30.3044433	-23.4618502	8.20	330.00	2136.00	230.00	151.00	194.00	9.70	26.90	693.00	39.00	56.94	252.06	0.40	566.97

Borehole nr.	Water type	X	Y	pH	EC	TDS	Ca	Mg	Na	K	Si	Cl	SO4	N	NO3	F	HCO3
H07-0873	Na-HCO3	30.5880687	-23.5935163	8.30	189.00	1389.00	88.00	56.00	241.00	5.80	24.00	257.00	12.00	0.17	0.75	0.50	726.70
H07-0874	Na-Cl	30.5875176	-23.5849012	8.40	151.00	1034.00	63.00	40.00	194.00	2.60	35.70	291.00	31.00	16.11	71.32	0.90	341.40
H07-0875	Mg-Cl	30.5855699	-23.5843453	7.76	565.00	3119.83	334.40	224.73	390.31	10.75	23.99	1523.38	34.10	39.20	173.53	0.34	428.15
H07-0876	Na-Cl	30.5875121	-23.5929550	7.60	309.00	1591.85	106.67	67.04	272.97	5.53	24.93	422.92	19.38	3.65	16.16	0.48	680.61
H07-0877	Na-Cl	30.5777949	-23.5999046	8.10	328.00	2320.00	140.00	161.00	369.00	3.70	37.80	809.00	27.00	20.60	91.19	0.40	718.17
H07-0890	Na-Cl	30.5724018	-23.5780972	8.20	415.00	2846.00	85.00	119.00	664.00	2.40	23.70	930.00	34.00	8.07	35.72	1.14	976.66
H07-0892	Mg-HCO3	30.5094516	-23.5407385	8.18	165.00	1221.56	55.38	41.49	64.12	0.95	39.04	133.57	19.73	3.01	13.34	1.25	289.57
H07-0896	Ca-HCO3	30.5105388	-23.5412940	7.51	110.20	740.48	81.77	47.75	64.12	1.98	36.65	137.14	37.97	18.00	79.68	0.34	289.57
H07-0897	Ca-HCO3	30.3112257	-23.6673962	8.10	36.70	303.00	30.00	11.00	30.00	1.50	16.20	7.00	4.00	0.04	0.18	1.30	219.47
H07-0899	Ca-HCO3	30.3304488	-23.5959844	7.70	64.00	477.00	55.00	26.00	41.00	0.60	24.90	47.00	6.00	3.72	16.47	0.90	284.10
H07-0900	Ca-HCO3	30.2686963	-23.6448976	8.10	38.90	330.00	51.00	8.00	19.00	0.40	15.30	9.00	6.00	0.49	2.17	0.40	232.89
H07-0904	Ca-HCO3	30.2980611	-23.6685065	6.90	11.10	93.00	8.00	4.00	9.00	1.70	18.90	5.00	4.00	0.95	4.21	0.10	59.75
H07-0909	Na-HCO3	30.4123687	-23.5523487	7.90	118.30	911.00	70.00	49.00	127.00	1.10	24.90	147.00	22.00	1.41	6.24	0.80	487.72
H07-0918	Na-Cl	30.3701900	-23.5717700	7.47	1202.00	7038.53	434.33	455.03	1571.81	5.58	19.78	3863.41	59.75	0.04	0.00	0.47	647.45
H07-0931	Na-HCO3	30.4602591	-23.6112892	8.00	100.20	766.00	72.00	43.00	89.00	2.60	12.30	143.00	35.00	3.87	17.13	0.36	362.13
H07-0944	Na-Cl	30.5875156	-23.6435081	8.20	404.00	2571.00	161.00	116.00	537.00	4.40	23.50	929.00	61.00	2.94	13.01	1.36	749.87
H07-0951	Na-HCO3	30.4370200	-23.3942700	8.00	108.20	869.30	42.55	54.98	112.75	3.56	25.95	95.44	19.71	2.67	0.00	0.99	527.47
H07-0974	Mg-HCO3	30.2767245	-23.6188994	7.54	24.40	179.36	10.20	12.56	15.29	0.76	32.57	10.00	4.00	1.04	4.59	0.27	128.61
H07-0975	Mg-HCO3	30.2691666	-23.6221196	7.50	22.10	167.00	16.00	11.00	13.00	1.00	33.30	11.00	6.00	0.31	1.37	0.20	108.52
H07-0976	Mg-HCO3	30.2588937	-23.6271178	7.90	20.40	149.00	12.00	9.00	15.00	1.40	25.90	10.00	6.00	0.33	1.46	0.10	95.11
H07-0977	Na-HCO3	30.3979237	-23.5450991	7.80	65.10	528.00	22.00	19.00	95.00	1.50	31.60	27.00	14.00	0.73	3.23	0.80	346.28
H07-0977A	Na-HCO3	30.3979515	-23.5449880	8.00	43.30	383.00	20.00	16.00	63.00	1.10	34.50	15.00	7.00	0.17	0.75	0.60	259.71
H07-0981	Na-HCO3	30.4375112	-23.4960197	8.40	164.00	1248.00	53.00	49.00	227.00	4.20	28.20	202.00	17.00	4.17	18.46	0.60	675.49
H07-0983	Mg-HCO3	30.4430088	-23.5003245	7.53	174.00	1190.91	101.63	72.66	133.75	6.92	30.95	213.31	21.39	43.11	190.83	0.64	449.99
H07-0983A	Mg-HCO3	30.4444510	-23.5013011	8.20	182.00	1220.00	109.00	83.00	126.00	7.60	33.30	261.00	12.00	33.63	148.87	0.40	471.87
H07-0984	Na-HCO3	30.4649700	-23.4719700	8.26	195.00	1354.94	91.83	75.74	199.18	9.30	32.40	266.05	14.85	18.38	0.00	0.62	615.87
H07-0984A	Na-HCO3	30.4647040	-23.4727153	8.20	178.00	1291.00	90.00	73.00	186.00	8.80	29.90	257.00	20.00	8.23	36.43	0.50	619.40
H07-0987	Ca-HCO3	30.2754744	-23.6445921	7.84	22.30	164.18	17.78	6.73	11.29	0.49	21.30	10.70	4.00	0.04	0.18	0.25	114.75
H07-0988	Ca-HCO3	30.2736687	-23.6460087	8.00	42.00	331.00	35.00	12.00	34.00	1.20	17.60	18.00	9.00	1.65	7.30	0.60	213.38
H07-0989	Na-HCO3	30.2865026	-23.6285377	8.30	48.20	336.39	26.97	17.58	38.83	0.96	2.16	41.46	4.00	0.04	0.18	1.04	206.16
H07-0990	Ca-HCO3	30.2922247	-23.6346228	8.00	42.00	331.00	35.00	12.00	34.00	1.20	17.60	18.00	9.00	1.65	7.30	0.01	213.38
H07-0991	Na-HCO3	30.2980586	-23.6255379	7.90	18.90	122.00	10.00	6.00	15.00	0.40	25.30	15.00	7.00	0.88	3.90	0.20	65.84
H07-0991A	Na-HCO3	30.2980586	-23.6255379	7.90	122.00	18.90	10.00	6.00	15.00	0.40	25.30	15.00	7.00	0.88	3.90	0.20	65.84
H07-0992	Ca-HCO3	30.2982809	-23.6223992	7.40	32.00	263.00	31.00	13.00	20.00	0.70	26.60	16.00	4.00	1.71	7.57	0.40	171.92
H07-0993	Na-HCO3	30.3129481	-23.6114278	8.17	34.00	214.29	11.72	2.40	47.99	0.46	0.91	41.49	6.85	0.08	0.36	1.95	100.65
H07-0994	Mg-HCO3	30.3476440	-23.5772080	8.20	66.30	489.00	39.00	41.00	35.00	1.00	37.50	38.00	10.00	3.74	16.56	0.40	308.48
H07-0995	Mg-HCO3	30.3237820	-23.5777634	8.10	48.50	382.00	28.00	33.00	31.00	1.20	37.60	48.00	4.00	2.79	12.35	0.20	224.35
H07-0995	Mg-HCO3	30.3237820	-23.5777634	7.57	61.50	450.64	32.20	37.19	36.27	1.09	38.74	48.16	9.06	4.13	18.28	0.24	268.04
H07-0997	Mg-HCO3	30.2496122	-23.6682293	8.30	33.10	292.00	25.00	24.00	13.00	1.40	26.40	6.00	11.00	2.30	10.18	0.20	202.40
H07-0998	Ca-HCO3	30.6180833	-23.4776663	8.20	57.60	469.00	51.00	17.00	48.00	0.90	26.40	28.00	7.00	0.05	0.22	1.50	314.58
H07-0999	Na-Cl	30.3744400	-23.5629500	8.76	238.00	1375.54	44.33	53.81	323.04	7.73	20.06	464.80	16.21	24.65	0.00	0.56	352.51
H07-0999A	Na-HCO3	30.3747279	-23.5624068	8.10	115.00	908.00	63.00	38.00	140.00	0.60	24.40	144.00	46.00	0.04	0.18	0.70	476.75
H07-1000	Mg-HCO3	30.2505289	-23.6668961	7.80	28.70	245.00	19.00	20.00	14.00	1.50	24.10	6.00	5.00	0.99	4.38	0.20	175.58
H07-1001	Ca-HCO3	30.2815302	-23.6391481	8.22	29.00	210.92	20.33	10.72	16.74	1.02	2.73	14.18	4.00	0.04	0.18	0.56	145.00

Borehole nr.	Water type	X	Y	pH	EC	TDS	Ca	Mg	Na	K	Si	Cl	SO4	N	NO3	F	HCO3
H07-1003	Ca-HCO3	30.2903300	-23.6271900	8.15	42.10	329.35	39.22	7.21	35.49	0.73	21.55	11.02	2.00	0.02	0.00	2.45	231.11
H07-1004	Ca-HCO3	30.3119507	-23.6629531	7.10	18.90	160.00	15.00	7.00	11.00	1.50	23.10	8.00	12.00	0.17	0.75	0.20	103.64
H07-1010	Na-HCO3	30.3575055	-23.5780690	8.10	77.10	725.00	29.00	16.00	151.00	1.50	26.60	33.00	7.00	0.04	0.18	1.80	486.50
H07-1012	Mg-HCO3	30.3544774	-23.6705071	7.44	38.80	279.78	25.81	17.90	17.50	2.61	22.65	20.78	4.00	0.05	0.20	0.31	192.56
H07-1013	Mg-HCO3	30.3319511	-23.6790587	8.30	27.90	226.00	20.00	13.00	20.00	1.40	28.20	11.00	4.00	1.78	7.88	0.20	151.19
H07-1019	Na-HCO3	30.3360878	-23.6772011	7.13	27.60	184.06	13.11	8.79	18.17	1.00	26.40	17.28	4.00	0.07	0.29	0.20	123.12
H07-1020	Ca-HCO3	30.2990842	-23.6302320	6.80	33.60	230.00	24.00	11.00	24.00	1.10	30.00	23.00	4.00	6.20	27.45	0.20	117.05
H07-1021	Na-HCO3	30.2978642	-23.6292599	6.90	18.00	127.00	10.00	5.00	18.00	0.50	18.40	15.00	4.00	0.60	2.66	0.20	73.16
H07-1022	Na-HCO3	30.2951974	-23.6312875	7.88	23.90	160.94	12.40	4.98	21.62	0.47	9.62	18.73	4.00	0.05	0.23	0.55	99.87
H07-1023	Ca-HCO3	30.3018921	-23.6303154	6.90	22.50	156.00	15.00	7.00	17.00	0.40	22.40	17.00	5.00	0.90	3.98	0.10	90.23
H07-1025	Mg-HCO3	30.2429730	-23.6648962	7.80	21.40	182.00	16.00	11.00	12.00	1.80	21.00	6.00	7.00	1.49	6.60	0.50	120.71
H07-1026	Ca-HCO3	30.3682556	-23.6889226	7.45	45.50	303.57	30.60	13.57	29.00	4.28	16.88	43.68	4.00	0.05	0.23	0.22	179.92
H07-1028	Na-NO3	30.2938640	-23.6360649	7.00	33.50	229.00	22.00	9.00	30.00	1.90	27.60	34.00	4.00	16.86	74.64	0.10	52.43
H07-1034	Na-HCO3	30.3548941	-23.6502308	6.90	13.60	116.00	7.00	4.00	14.00	2.00	23.30	6.00	6.00	1.77	7.84	0.20	69.50
H07-1036	Mg-HCO3	30.3286432	-23.5803744	7.60	63.20	443.00	37.00	31.00	40.00	1.20	35.30	68.00	19.00	2.98	13.19	0.40	232.89
H07-1039	Ca-HCO3	30.2367534	-23.6590599	7.50	22.30	173.00	17.00	7.00	16.00	1.70	23.60	7.00	4.00	8.23	36.43	0.10	84.13
H07-1042	Na-HCO3	30.3112813	-23.6730347	7.10	13.80	99.00	7.00	4.00	14.00	2.00	19.60	8.00	4.00	1.03	4.56	0.10	58.53
H07-1044	Na-HCO3	30.3100057	-23.6629534	7.40	17.30	127.00	11.00	4.00	13.00	0.80	18.30	6.00	4.00	2.05	9.07	0.40	79.25
H07-1046	Ca-HCO3	30.3166638	-23.6562903	7.50	25.10	197.00	21.00	6.00	15.00	4.10	8.10	8.00	6.00	0.15	0.66	0.40	134.12
H07-1047	Ca-HCO3	30.3119460	-23.6432345	7.20	0.70	87.00	8.00	4.00	7.00	0.80	19.50	5.00	4.00	2.19	9.69	0.20	49.99
H07-1049	Na-HCO3	30.2940328	-23.6961719	8.00	30.20	217.00	15.00	3.00	46.00	1.20	16.70	23.00	6.00	0.53	2.35	3.60	117.05
H07-1051	Ca-HCO3	30.2798300	-23.6346600	8.23	54.20	428.12	50.64	13.44	39.59	2.07	15.08	21.78	2.00	0.40	0.00	2.16	294.59
H07-1051	Ca-HCO3	30.2795579	-23.6353983	8.10	56.10	478.00	63.00	17.00	38.00	2.60	21.10	22.00	11.00	0.05	0.22	1.50	321.90
H07-1058	Na-HCO3	30.4683330	-23.3986110	7.63	69.20	528.39	42.13	29.11	65.49	0.89	37.82	50.84	10.94	2.25	0.00	0.50	318.31
H07-1074	Ca-HCO3	30.2991670	-23.6302780	8.11	37.90	252.24	26.33	9.44	27.05	0.84	28.46	31.74	4.95	5.04	0.00	0.44	129.12
H07-1077	Na-HCO3	30.3978600	-23.5510197	7.94	126.80	996.04	67.12	42.00	147.48	2.34	28.79	102.22	10.34	29.41	130.19	0.54	493.69
H07-1078	Mg-HCO3	30.5162800	-23.5256677	8.08	112.20	813.61	68.52	56.61	95.69	2.00	23.52	165.24	19.49	19.86	87.93	0.53	317.52
H07-1080	Na-Cl	30.5130600	-23.4308500	8.39	239.00	1517.54	96.60	97.04	203.66	9.34	31.37	326.42	35.44	42.40	0.00	0.39	560.88
H07-1105	Na-HCO3	30.3888956	-23.5471268	7.72	44.90	330.63	26.63	17.46	38.68	0.64	29.80	27.21	4.00	0.41	1.81	0.30	215.79
H07-1108	Na-HCO3	30.5095943	-23.5369610	8.43	94.10	837.86	34.13	37.29	131.79	12.76	22.35	21.94	11.80	0.10	0.44	0.95	586.00
H07-1109	Na-HCO3	30.5103721	-23.5381276	7.51	93.30	816.09	51.32	46.54	102.28	0.68	29.55	32.58	4.93	0.04	0.18	0.64	576.97
H07-1133	Na-Cl	30.5523880	-23.4771327	7.90	185.00	1157.80	84.85	65.22	176.12	3.83	26.17	250.78	42.08	58.38	258.44	0.35	276.56
H07-1147	Na-HCO3	30.4660000	-23.4860500	8.70	112.40	874.71	64.23	53.66	104.96	3.42	30.44	122.99	11.76	10.46	0.00	0.46	466.89
H07-1148	Mg-HCO3	30.4597300	-23.4968500	8.06	121.80	932.48	87.28	63.58	79.95	1.54	30.03	135.42	14.68	20.41	0.00	0.43	459.14
H07-1179	Na-HCO3	30.3208500	-23.4568000	8.49	125.30	998.86	85.18	55.94	112.70	3.84	22.62	115.63	20.36	22.67	0.00	0.60	504.06
H07-1181	Ca-Cl	30.3130873	-23.4635490	7.84	220.00	1362.07	152.39	70.60	151.38	4.30	28.71	355.68	26.50	39.56	175.14	0.45	425.58
H07-1195	Na-HCO3	30.3606166	-23.6388704	7.55	13.90	97.37	6.72	3.19	10.30	5.04	21.33	6.60	6.00	1.64	7.27	0.20	54.96
H07-1198	Mg-HCO3	30.5071100	-23.4889700	8.34	104.00	837.71	61.64	55.31	79.52	8.25	19.62	65.24	27.24	14.38	0.00	0.54	471.87
H07-1204	Na-HCO3	30.2373280	-23.6593966	7.32	26.90	193.44	14.89	8.67	20.61	1.66	20.72	15.14	10.31	8.22	36.37	0.20	85.60
H07-1222	Mg-HCO3	30.4477500	-23.3987500	7.65	77.40	540.01	58.12	39.92	35.94	0.91	39.80	56.67	17.26	3.95	0.00	0.27	313.31
H07-1235	Na-NO3	30.4785550	-23.6560267	7.92	58.20	367.97	23.25	20.79	50.29	4.52	27.36	47.79	38.56	21.08	93.32	0.13	89.13
H07-1238	Na-Cl	30.5321220	-23.6238718	7.98	614.00	3838.93	398.90	191.28	684.54	17.64	15.04	1920.65	159.11	3.98	17.62	0.63	447.85
H07-1249	Na-HCO3	30.5372062	-23.6311213	7.71	34.80	232.54	6.34	7.37	45.50	0.80	37.11	22.20	21.81	11.41	50.51	0.22	77.57
H07-1250	Mg-HCO3	30.3743669	-23.7426689	8.15	49.50	328.91	26.57	22.11	29.92	1.88	32.29	47.03	4.30	4.79	21.20	0.26	175.59

Borehole nr.	Water type	X	Y	pH	EC	TDS	Ca	Mg	Na	K	Si	Cl	SO4	N	NO3	F	HCO3
H07-1257	Ca-HCO3	30.2191100	-23.6473597	7.60	27.10	176.16	18.87	7.44	13.99	1.00	29.08	19.59	4.00	1.61	7.13	0.50	105.59
H07-1271	Na-HCO3	30.4156173	-23.6342597	7.88	63.50	477.12	44.24	18.88	52.06	2.77	26.48	17.80	6.00	0.13	0.55	0.64	337.14
H07-1299	Mg-HCO3	30.3506600	-23.6922700	7.40	35.40	265.95	20.78	18.32	19.77	4.42	30.78	20.52	3.00	1.54	0.00	0.10	172.01
H07-1300	Na-HCO3	30.4177826	-23.6766735	7.74	84.70	624.07	36.99	28.19	87.84	14.02	14.08	80.22	20.04	3.31	14.64	0.28	341.77
H07-1303	Na-Cl	30.5854292	-23.5821525	7.94	211.00	1359.55	83.61	67.60	211.36	7.30	33.40	250.64	33.65	79.24	350.80	0.66	353.82
H07-1304	Na-HCO3	30.4860200	-23.7361100	8.05	124.30	1007.37	49.46	57.63	145.80	4.49	28.47	134.34	12.09	17.88	0.00	0.81	523.57
H07-1305	Na-HCO3	30.4192840	-23.6757569	7.73	68.10	473.66	33.62	20.11	68.06	7.76	26.34	56.27	17.91	13.88	61.44	0.28	208.08
H07-1308	Mg-HCO3	30.2480000	-23.6618000	7.49	16.10	105.02	8.65	5.89	9.98	0.95	19.92	8.45	3.00	1.51	0.00	0.10	61.21
H07-1310	Mg-HCO3	30.4365000	-23.3953600	7.99	97.60	858.25	47.33	56.42	100.45	3.47	25.66	57.08	12.93	0.21	0.00	0.82	578.80
H07-1359	Na-HCO3	30.3089700	-23.4963800	6.49	11.92	80.60	5.79	3.43	11.45	1.48	19.45	10.60	2.00	1.78	0.00	0.10	37.82
H07-1368	Na-HCO3	30.3233300	-23.4988300	7.99	182.00	1234.65	94.27	63.39	161.06	5.88	31.97	208.57	4.65	17.08	0.00	0.55	620.62
H07-1389	Mg-HCO3	30.3500000	-23.4342500	8.25	58.50	444.33	40.96	26.28	42.76	0.87	34.22	45.40	24.39	0.67	0.00	0.32	260.31
H07-1407	Na-HCO3	30.3699400	-23.4636900	8.53	162.00	1177.06	53.51	52.01	198.18	12.26	31.39	168.17	14.34	16.38	0.00	0.64	605.38
H07-1408	Mg-HCO3	30.4351100	-23.3937200	8.03	85.80	726.07	42.18	53.81	73.06	4.61	30.61	67.59	9.16	3.97	0.00	0.80	457.29
H07-1409	Mg-HCO3	30.2500000	-23.6672220	8.33	40.40	271.93	25.17	23.72	13.70	1.44	33.83	13.37	5.41	1.41	0.00	0.28	182.53
H07-1413	Na-Cl	30.3955200	-23.5526600	8.21	202.00	1218.04	120.70	73.61	147.77	1.95	24.40	345.71	41.76	32.96	0.00	0.50	340.09
H08-0748	Mg-HCO3	30.2872200	-23.2399580	7.94	60.30	444.53	42.34	36.30	16.17	0.79	23.19	22.82	6.22	6.39	0.00	0.17	291.34
H08-1297	Ca-HCO3	30.3754700	-23.3980200	8.02	120.30	868.31	116.49	50.97	67.72	2.06	27.42	184.30	16.57	24.95	0.00	0.31	319.40
H08-1322	Ca-HCO3	30.2394700	-23.9293300	8.01	70.40	598.91	62.92	27.15	56.48	4.59	18.19	51.94	16.57	3.98	0.00	0.64	360.88
H10-0002	Na-HCO3	30.3455560	-23.4044440	8.01	57.90	493.00	40.90	25.20	58.40	0.94	37.01	24.50	10.00	0.17	0.00	0.66	331.53
H10-0007	Na-HCO3	30.3244440	-23.4022220	8.18	167.00	1319.00	101.00	76.40	169.00	1.98	34.00	204.10	55.10	38.21	0.00	0.68	541.25
H10-0012	Na-HCO3	30.2658330	-23.4072220	7.95	166.00	1217.00	86.40	72.90	155.30	11.14	28.59	194.10	20.00	25.33	0.00	0.41	564.54
H10-0013	Mg-HCO3	30.2447220	-23.4158330	8.06	94.10	757.53	52.33	46.32	78.15	11.97	30.09	59.00	14.61	13.39	0.00	0.31	435.52
H10-0015	Mg-Cl	30.2714500	-23.3298100	8.51	134.00	980.00	89.20	86.90	47.70	2.80	26.90	174.40	31.90	40.80	180.60	0.20	250.40
H10-0015	Na-HCO3	30.2715500	-23.3291100	7.99	87.80	655.71	43.33	33.72	84.77	4.62	26.31	52.75	11.85	11.91	0.00	0.45	371.37
H10-0022	Na-HCO3	30.2729100	-23.3294400	7.99	75.50	594.97	33.84	29.60	72.68	6.37	24.01	26.14	10.81	4.98	0.00	0.51	392.95
H10-0024	Mg-HCO3	30.1786110	-23.3752780	7.78	52.20	405.00	16.90	30.60	45.70	14.26	33.72	39.20	7.50	7.77	0.00	0.15	216.67
H10-0028	Mg-HCO3	30.1743900	-23.3848500	8.39	60.00	408.00	26.10	32.50	38.80	8.70	20.30	46.40	10.30	15.34	67.90	0.10	150.80
H10-0028	Mg-HCO3	30.1750000	-23.3836110	7.54	57.60	422.08	26.53	33.06	32.24	8.23	28.60	31.92	9.02	13.74	0.00	0.22	219.97
H10-0029	Mg-HCO3	30.1780560	-23.3755560	7.16	50.10	393.93	17.32	29.10	36.35	14.28	31.22	49.53	14.66	10.87	0.00	0.19	184.23
H10-0034	Mg-HCO3	30.1624400	-23.4466900	7.85	78.90	756.58	47.12	51.57	49.56	7.59	33.33	44.52	19.35	39.98	0.00	0.26	359.49
H10-0151	Mg-HCO3	30.1486110	-23.3700000	8.39	58.00	435.00	38.40	35.90	21.40	2.46	34.39	26.40	9.10	2.47	0.00	0.21	290.44
H10-0165	Mg-HCO3	30.2374200	-23.3590900	8.71	117.00	840.00	48.70	97.30	64.70	6.70	31.60	77.90	20.50	28.60	126.60	0.30	385.20
H10-0165	Mg-HCO3	30.2369440	-23.3583330	7.81	118.40	903.00	45.90	90.40	66.30	6.71	29.17	76.30	12.70	21.78	0.00	0.35	507.72
H10-0167	Mg-HCO3	30.2358330	-23.3491670	8.62	85.80	646.00	41.30	53.30	50.50	9.56	32.55	45.20	16.60	18.52	0.00	0.42	346.77
H10-0169	Mg-HCO3	30.2147220	-23.3905560	8.05	46.20	372.00	28.50	28.50	26.20	2.31	22.31	31.80	11.90	0.11	0.00	0.21	242.64
H10-0171	Mg-HCO3	30.2347220	-23.3625000	8.28	97.40	811.00	50.90	66.10	74.00	4.99	22.34	54.20	11.10	9.47	0.00	0.48	507.23
H10-0181	Mg-HCO3	30.2002780	-23.4225000	7.80	59.20	466.00	28.80	33.00	47.40	7.35	34.86	18.60	6.50	2.30	0.00	0.27	314.09
H10-0183	Na-HCO3	30.2033330	-23.4202780	8.34	70.30	529.00	49.20	25.30	57.40	11.98	17.15	53.40	25.10	0.07	0.00	0.22	305.56
H10-0186	Mg-HCO3	30.1533300	-23.4602700	7.37	64.40	554.78	47.35	43.75	36.80	6.56	32.82	42.40	26.29	7.36	0.00	0.43	318.38
H10-0188	Mg-HCO3	30.1530500	-23.4388800	7.36	47.60	446.11	29.43	33.25	28.77	7.76	31.00	13.21	14.14	1.89	0.00	0.30	310.59
H10-0191	Mg-HCO3	30.1536110	-23.4155560	7.71	93.40	664.69	47.24	64.06	46.24	8.04	30.33	100.62	21.09	13.09	0.00	0.27	319.08
H10-0194	Mg-HCO3	30.1458330	-23.4172220	7.62	53.00	462.28	34.32	30.87	41.90	2.16	21.24	38.16	15.15	0.09	0.00	0.38	298.77
H10-0196	Na-HCO3	30.1444440	-23.4183330	8.16	68.70	571.00	45.30	21.00	75.30	4.48	22.76	20.00	12.40	0.06	0.00	0.48	391.64

Borehole nr.	Water type	X	Y	pH	EC	TDS	Ca	Mg	Na	K	Si	Cl	SO4	N	NO3	F	HCO3
H10-0198	Na-HCO3	30.1461110	-23.4138890	7.81	84.70	637.00	49.80	31.80	84.30	3.31	24.75	77.50	61.20	3.70	0.00	0.60	312.14
H10-0213	Mg-HCO3	30.0536110	-23.4472220	8.02	46.20	378.00	25.10	33.40	18.20	7.95	28.36	10.90	8.60	1.37	0.00	0.14	267.76
H10-0214	Mg-HCO3	30.0480560	-23.4580560	8.24	58.90	443.97	12.98	61.94	10.19	2.67	36.09	20.56	10.47	11.88	0.00	0.10	272.35
H10-0342	Mg-HCO3	30.1530560	-23.3758330	8.30	70.20	520.00	43.70	42.40	25.60	8.79	25.65	32.40	4.70	11.63	0.00	0.25	310.56
H10-0421	Mg-HCO3	30.0390500	-23.4479100	8.22	35.50	269.60	21.99	17.69	17.43	6.27	25.41	15.37	8.96	0.80	0.00	0.10	177.98
H10-0423	Mg-HCO3	30.1121400	-23.4045000	8.40	44.00	276.00	28.20	19.30	28.90	5.00	17.10	27.90	7.20	3.57	15.80	0.10	148.10
H10-0423	Mg-HCO3	30.1123300	-23.4035800	7.80	49.60	353.03	31.56	21.06	31.57	5.64	27.60	27.77	3.00	4.89	0.00	0.40	210.33
H10-0431	Mg-HCO3	30.1447220	-23.3613890	8.04	72.00	528.08	36.41	38.19	50.22	5.09	31.38	81.36	24.07	12.54	0.00	0.37	236.81
H10-0436	Na-HCO3	30.1480800	-23.3898600	8.04	54.00	418.40	32.70	18.04	42.88	14.26	28.86	29.95	18.48	0.11	0.00	0.27	261.09
H10-0437	Mg-HCO3	30.1516500	-23.3891200	8.59	62.00	292.00	38.20	31.10	43.50	9.50	21.90	34.70	16.50	1.49	6.60	0.20	243.00
H10-0461	Mg-HCO3	30.1595500	-23.4361900	7.74	70.40	560.12	39.65	46.06	42.58	7.32	30.37	30.84	10.00	1.09	0.00	0.27	378.45
H10-0472	Mg-HCO3	30.2355560	-23.3505560	8.17	134.00	979.00	66.90	88.90	79.00	7.91	15.09	157.70	18.20	29.99	0.00	0.37	425.54
H10-0479	Mg-HCO3	30.1492100	-23.3913700	7.55	73.90	513.61	36.24	37.54	49.13	13.01	27.77	76.58	14.49	3.08	0.00	0.39	272.49
H10-0580	Mg-HCO3	30.0504900	-23.4542900	8.34	18.40	150.16	11.17	9.82	8.79	2.04	31.78	5.00	4.74	0.10	0.00	0.24	107.78
H10-0604	Mg-HCO3	30.1536600	-23.3666100	7.42	50.50	364.81	32.09	25.60	23.28	0.99	26.66	26.48	15.09	3.74	0.00	0.22	224.02
H10-0614	Mg-HCO3	30.2925900	-23.3063300	8.65	81.00	506.00	40.40	42.20	68.60	4.90	28.50	59.10	7.60	7.12	31.50	0.20	290.40
H10-0617	Ca-HCO3	30.0597220	-23.4444440	7.44	30.00	215.52	19.26	10.54	19.03	1.89	16.67	11.17	2.00	0.04	0.00	0.21	151.08
H10-0624	Na-HCO3	30.0019440	-23.4594440	7.36	17.90	124.03	9.33	5.93	11.87	2.38	25.60	5.00	2.00	0.47	0.00	0.05	85.07
H10-0629	Mg-HCO3	30.3085500	-23.2963800	8.59	107.00	690.00	57.20	54.30	77.50	8.10	29.80	114.50	19.60	23.02	101.90	0.20	264.90
H10-0629	Mg-HCO3	30.3086100	-23.2958300	7.87	97.90	767.18	53.04	51.55	82.22	8.12	35.19	100.74	18.82	23.06	0.00	0.27	350.24
H10-0633	Mg-HCO3	30.2959400	-23.3039700	7.71	88.30	745.98	53.68	45.83	80.48	7.86	33.92	70.79	17.72	19.47	0.00	0.30	382.91
H10-0636	Na-HCO3	30.0451100	-23.3606100	7.16	19.20	120.76	9.52	4.28	15.70	1.23	25.43	10.67	2.00	0.76	0.00	0.14	73.63
H10-0657	Mg-HCO3	30.1461000	-23.4394400	7.67	44.50	393.51	26.44	30.82	22.87	6.23	31.96	11.66	6.95	0.53	0.00	0.30	285.73
H10-0661	Mg-Cl	30.2769300	-23.3405200	8.56	138.00	1124.00	93.90	90.30	49.10	2.80	29.00	172.30	31.50	40.82	180.70	0.20	258.20
H10-0662	Mg-HCO3	30.0688890	-23.3783330	6.82	28.90	188.67	13.46	16.62	11.84	2.84	22.65	19.69	21.15	3.79	0.00	0.16	86.10
H10-0674	Mg-HCO3	30.1639700	-23.3926900	8.59	72.00	436.00	25.70	56.60	32.90	8.50	26.90	42.60	9.40	9.10	40.30	0.20	259.00
H10-0674	Mg-HCO3	30.0675000	-23.3480560	8.39	71.70	577.93	25.96	56.51	35.86	10.09	39.42	46.42	7.78	12.69	0.00	0.30	338.76
H10-0715	Mg-HCO3	30.1466800	-23.3483200	8.64	63.00	382.00	33.70	38.80	35.00	6.80	19.20	47.30	7.00	7.39	32.70	0.05	213.80
H10-0743	Mg-HCO3	30.3233000	-23.2865000	7.70	83.30	749.71	48.26	53.15	70.14	7.78	28.39	39.92	16.47	9.43	0.00	0.36	471.74
H10-0748	Na-Cl	30.1511300	-23.4113600	7.77	118.80	819.96	75.50	36.74	119.13	11.33	27.30	166.53	73.67	16.23	0.00	0.57	264.49
H10-0752	Mg-HCO3	30.1080600	-23.4057600	8.53	53.00	314.00	35.50	22.60	34.10	4.90	18.10	39.30	11.10	6.94	30.70	0.10	157.40
H10-0752	Mg-HCO3	30.1083300	-23.4050500	8.11	59.20	381.90	34.12	22.27	29.28	4.90	26.95	40.67	9.85	8.33	0.00	0.18	203.64
H10-0755	Mg-HCO3	30.0335200	-23.4475200	7.61	38.50	283.69	26.69	18.10	18.38	3.36	22.98	18.06	2.00	2.86	0.00	0.15	184.13
H14-0002	Mg-Cl	30.7118507	-23.5702091	8.08	234.00	1482.31	109.87	109.47	190.56	7.15	35.69	399.48	36.63	10.36	45.86	0.65	582.46
H14-0003	Mg-Cl	30.6989091	-23.5674070	7.58	248.00	1313.39	125.15	109.11	163.20	5.61	34.25	415.32	15.77	0.04	0.18	0.70	478.15
H14-0004	Na-Cl	30.6953779	-23.5684869	8.69	198.00	1088.04	12.45	76.75	228.98	3.05	1.53	424.41	8.38	0.04	0.19	0.56	332.98
H14-0005	Na-Cl	30.6900720	-23.5721533	7.87	42.10	253.00	31.40	22.90	23.50	3.50	0.00	42.50	8.00	0.40	1.77	0.12	184.11
H14-0006	Na-HCO3	30.6500000	-23.5988877	7.32	117.00	723.00	84.50	52.60	113.00	4.00	0.00	119.50	15.70	8.10	35.86	0.60	615.75
H14-0007	Na-HCO3	30.6478205	-23.5801527	7.55	64.00	374.00	29.50	19.50	94.50	4.70	0.98	65.10	16.80	0.00	0.00	0.82	341.77
H14-0009	Na-Cl	30.6594040	-23.5738476	6.96	339.00	1901.00	159.60	116.00	236.60	5.80	0.00	655.00	32.50	13.30	58.88	1.00	479.43
H14-0010	Na-HCO3	30.6595159	-23.5700701	7.37	132.70	786.00	63.10	49.80	172.50	8.00	0.00	145.00	12.00	0.10	0.44	0.76	645.99
H14-0018	Mg-HCO3	30.7825719	-23.5886857	6.93	129.90	1005.00	107.80	65.90	89.20	3.50	0.00	150.00	50.00	25.50	112.88	0.70	534.91
H14-0020A	Mg-Cl	30.7940756	-23.5833472	7.98	637.00	4052.56	394.54	273.17	512.66	8.13	27.99	1589.65	115.11	67.55	299.03	0.43	857.66
H14-0025	Na-HCO3	30.8255765	-23.6008183	8.12	239.00	1657.27	71.39	68.87	331.59	4.06	35.21	297.88	27.91	5.77	25.54	1.17	828.76

Borehole nr.	Water type	X	Y	pH	EC	TDS	Ca	Mg	Na	K	Si	Cl	SO4	N	NO3	F	HCO3
H14-0026	Na-HCO3	30.8295211	-23.6010405	7.54	93.70	593.00	59.90	38.40	92.00	2.00	0.00	61.30	10.00	2.50	11.07	0.91	521.62
H14-0030	Na-HCO3	30.8796111	-23.6599997	6.96	161.80	921.00	56.60	52.60	203.50	3.00	0.00	197.90	56.00	23.70	104.92	0.88	562.34
H14-0032	Na-HCO3	30.8875504	-23.6666194	7.55	171.60	937.00	75.10	56.90	208.00	7.50	0.00	224.70	32.50	4.10	18.15	1.01	675.00
H14-0036	Na-Cl	30.8881944	-23.6704163	7.90	378.00	2304.30	205.48	134.56	342.71	8.18	33.90	875.06	148.72	12.46	55.16	0.66	701.59
H14-0037	Na-Cl	30.8864115	-23.6729523	6.72	503.00	2825.00	241.00	137.00	465.00	5.60	0.00	1012.20	112.00	1.40	6.20	0.78	646.23
H14-0043	Na-HCO3	30.7897411	-23.6373704	8.19	123.30	1062.40	54.91	60.61	143.98	13.89	10.10	101.29	23.73	0.78	3.45	0.84	750.24
H14-0044	Mg-HCO3	30.7392682	-23.6366768	7.85	207.00	1364.13	104.15	87.62	164.43	4.97	40.98	255.47	71.32	47.04	208.24	0.91	466.87
H14-0045	Mg-Cl	30.7364626	-23.6308438	7.95	219.00	1329.82	140.58	91.43	146.21	2.62	41.01	283.54	74.26	39.97	176.94	0.72	413.42
H14-0049	Na-HCO3	30.7237122	-23.6418431	7.07	118.90	745.00	68.30	44.30	112.30	4.00	0.08	186.70	36.20	5.70	25.23	1.01	353.48
H14-0050	Na-HCO3	30.7090173	-23.6187891	7.04	248.00	1286.00	102.10	86.80	199.80	3.00	0.00	302.40	49.00	21.70	96.06	0.85	659.15
H14-0052	Mg-HCO3	30.6973781	-23.6160115	7.14	255.00	1490.00	110.10	112.00	156.50	2.50	0.00	252.40	59.00	38.00	168.22	0.80	755.48
H14-0053	Mg-HCO3	30.6968503	-23.6155948	7.24	149.00	954.00	94.40	95.00	117.00	2.50	0.00	152.50	15.00	7.60	33.64	0.89	726.58
H14-0056	Na-Cl	30.7012117	-23.5581821	8.13	292.00	1758.10	151.21	103.73	244.62	9.39	12.25	673.68	27.48	0.04	0.18	0.40	546.49
H14-0057	Mg-Cl	30.7114618	-23.5450719	7.80	332.00	1706.00	105.10	142.80	168.40	7.30	0.00	445.60	44.00	25.20	111.56	0.24	551.00
H14-0057A	Na-Cl	30.7080730	-23.5468496	7.26	285.00	1623.00	98.00	128.60	318.50	6.50	0.00	546.80	65.50	23.10	102.26	0.77	736.46
H14-0058	Mg-HCO3	30.7205455	-23.5479606	7.17	123.50	801.00	84.00	56.00	104.00	6.50	0.00	162.00	5.00	4.40	19.48	0.64	512.47
H14-0059A	Mg-HCO3	30.7034061	-23.4909645	7.38	68.80	526.00	39.20	32.10	57.00	3.00	0.00	37.40	12.30	0.10	0.44	1.01	367.01
H14-0061	Na-HCO3	30.6964059	-23.4968530	8.02	253.00	1732.39	84.69	71.87	337.68	1.41	32.36	297.80	59.94	51.18	226.56	1.46	650.86
H14-0064	Mg-HCO3	30.7143515	-23.2254273	7.31	87.60	526.00	46.80	51.80	70.20	3.60	0.00	58.80	33.60	2.00	8.85	0.88	465.04
H14-0067	Mg-HCO3	30.6179594	-23.2027898	6.96	86.40	531.00	60.40	49.90	52.50	5.80	0.00	48.60	7.00	3.40	15.05	0.26	488.21
H14-0072	Mg-Cl	30.6255151	-23.2402317	6.98	312.00	1809.00	140.20	141.30	241.60	3.70	0.00	502.40	13.00	7.10	31.43	0.20	693.05
H14-0073	Na-Cl	30.6263762	-23.2367319	7.01	276.00	1451.00	104.80	103.10	229.30	2.90	0.00	428.30	8.50	3.70	16.38	0.23	635.13
H14-0075	Mg-Cl	30.7070450	-23.5489327	7.53	409.00	2446.86	166.93	207.67	309.94	15.31	24.67	877.76	41.15	39.98	176.98	0.66	650.25
H14-0079	Na-HCO3	30.7864365	-23.5412390	7.10	170.70	1030.00	80.70	70.60	202.00	6.00	0.00	234.90	37.50	6.00	26.56	1.04	669.64
H14-0081	Na-HCO3	30.7956590	-23.5331840	6.98	151.70	802.00	85.10	54.60	176.50	13.50	0.00	214.90	2.00	13.70	60.65	0.48	619.16
H14-0082A	Na-HCO3	30.8039647	-23.5502384	7.42	130.10	807.00	70.50	58.40	160.50	18.00	0.00	119.10	9.00	0.00	0.00	0.56	732.92
H14-0082B	Na-HCO3	30.8039370	-23.5502106	7.97	157.00	1173.96	63.01	64.25	164.75	19.45	27.85	148.09	14.28	6.74	29.84	0.51	669.64
H14-0084	Na-HCO3	30.7684916	-23.5153518	7.30	190.90	1133.00	103.30	73.60	193.50	13.50	0.00	303.20	3.00	8.20	36.30	0.73	669.40
H14-0085	Na-Cl	30.7636303	-23.5147963	7.11	246.00	1395.00	101.10	90.60	204.50	11.50	0.00	379.40	32.50	14.00	61.98	0.86	585.26
H14-0087	Na-HCO3	30.7610747	-23.5123520	7.43	167.00	1042.00	77.10	63.80	151.50	6.50	0.00	198.40	44.20	6.00	26.56	1.15	588.80
H14-0088A	Na-HCO3	30.8402437	-23.5427667	7.71	174.20	1015.00	56.40	66.00	260.70	11.30	0.00	210.40	37.50	0.90	3.98	1.04	765.23
H14-0090	Na-HCO3	30.8406882	-23.5427112	7.85	180.80	1112.00	67.10	77.60	265.00	11.50	0.00	254.90	30.60	0.20	0.89	1.02	785.11
H14-0091	Na-HCO3	30.8393270	-23.5418779	7.45	192.40	1164.00	87.10	85.80	178.20	7.00	0.00	258.90	28.80	2.00	8.85	0.80	688.66
H14-0093(1)	Na-Cl	30.8452439	-23.5443222	7.93	276.00	1847.32	88.43	86.19	350.58	16.37	30.69	465.80	43.93	2.90	12.84	0.59	782.42
H14-0094(1)	Na-HCO3	30.8505773	-23.5493496	7.99	233.00	1560.56	76.11	83.84	252.29	13.84	26.97	297.59	43.98	0.13	0.56	0.67	791.45
H14-0097	Na-HCO3	30.8224654	-23.5567102	8.93	157.00	1166.38	45.59	61.34	185.04	16.38	14.16	178.17	4.41	0.14	0.61	0.61	673.91
H14-0100	Mg-HCO3	30.5982646	-23.2280102	7.73	79.30	653.78	47.01	44.17	64.79	2.32	28.16	41.36	13.68	8.44	37.36	0.28	402.31
H14-0103	Mg-HCO3	30.5519008	-23.2211218	6.59	96.90	596.00	60.70	57.10	63.80	1.70	0.00	98.30	1.00	38.60	170.87	0.21	296.66
H14-0104	Na-HCO3	30.5932645	-23.1964569	7.22	104.90	645.00	65.70	46.20	93.50	1.60	0.00	101.80	5.10	26.60	117.75	0.31	362.38
H14-0106	Na-HCO3	30.7162128	-23.2279827	7.84	249.00	1507.02	66.34	102.92	295.09	8.69	35.74	310.78	74.87	3.98	17.62	1.02	629.52
H14-0118	Mg-HCO3	30.7859646	-23.4011930	7.14	164.40	986.00	96.80	93.10	162.30	5.50	0.00	131.80	14.50	4.00	17.71	0.31	909.84
H14-0119	Mg-HCO3	30.7946315	-23.4033040	7.81	159.00	1170.46	68.04	78.26	134.45	3.73	37.17	102.60	25.07	32.85	145.42	0.40	612.33
H14-0125	Mg-Cl	30.5807082	-23.3798053	7.38	247.00	1534.15	163.15	108.08	121.19	9.43	25.52	395.99	48.58	76.25	337.54	0.62	349.10
H14-0127	Mg-HCO3	30.7045451	-23.5775419	8.10	179.00	1299.94	77.07	91.48	156.65	6.30	37.14	196.71	23.72	14.37	63.61	0.93	683.17

Borehole nr.	Water type	X	Y	pH	EC	TDS	Ca	Mg	Na	K	Si	Cl	SO4	N	NO3	F	HCO3
H14-0128	Mg-HCO3	30.7158787	-23.5777363	6.93	131.80	774.00	75.90	68.70	94.50	6.40	0.00	119.60	4.40	2.80	12.40	0.22	643.18
H14-0131	Na-HCO3	30.7250180	-23.5534880	7.72	240.00	1520.82	97.97	101.76	193.62	15.95	32.92	299.39	24.34	15.35	67.95	0.74	718.90
H14-0132	Na-HCO3	30.8701057	-23.5631265	8.11	108.10	809.73	30.73	30.47	150.97	5.67	29.76	93.03	16.21	0.43	1.90	0.27	479.32
H14-0133(1)	Na-HCO3	30.8687167	-23.5648208	7.44	256.00	1410.00	120.00	94.60	244.40	10.50	0.00	417.40	30.00	0.00	0.00	0.56	729.75
H14-0136A	Mg-HCO3	30.7429075	-23.5111021	7.20	196.50	1171.00	76.90	101.70	189.50	5.50	0.54	297.40	24.00	2.60	11.51	0.62	695.98
H14-0146	Na-HCO3	30.8964119	-23.5981241	7.38	127.00	814.00	75.90	69.40	158.80	6.00	0.00	171.20	25.40	2.30	10.18	1.69	664.15
H14-0154	Na-HCO3	30.9669419	-23.5744592	7.59	165.89	935.00	36.00	62.10	260.80	9.00	0.07	242.40	24.50	0.20	0.89	1.27	663.42
H14-0155	Na-Cl	30.9623584	-23.5688762	7.98	437.00	2529.69	144.47	191.98	412.62	12.29	37.27	1055.70	86.67	0.92	4.07	0.64	621.11
H14-0157	Na-Cl	30.9661085	-23.5762369	7.70	257.00	1690.68	94.06	91.97	305.73	10.36	34.74	451.97	70.79	11.52	50.98	0.75	614.04
H14-0159	Mg-HCO3	31.0271380	-23.6102346	7.40	275.00	1389.00	99.80	128.80	141.00	6.30	0.00	357.40	30.50	3.70	16.38	0.77	647.94
H14-0164	Na-HCO3	31.0656670	-23.5526831	7.06	117.90	725.00	62.70	50.20	108.50	10.00	0.00	86.60	30.40	4.60	20.36	0.85	570.02
H14-0167	Na-HCO3	31.0506388	-23.5586549	8.18	152.00	1102.63	67.70	51.72	183.26	8.03	34.60	175.61	16.04	6.50	28.77	0.63	570.63
H14-0168	Mg-Cl	30.9582195	-23.5106580	6.76	311.50	1838.00	108.20	114.90	182.20	7.50	0.00	434.80	44.80	20.80	92.08	0.68	602.09
H14-0175	Na-HCO3	30.8676058	-23.4761880	7.75	187.00	1406.79	88.78	63.19	208.66	1.39	24.55	179.05	42.54	2.76	12.22	1.06	809.74
H14-0176	Na-Cl	30.8570777	-23.4883538	7.61	393.00	2456.31	206.87	145.68	375.53	8.49	27.19	943.06	43.60	37.32	165.21	0.57	567.10
H14-0178	Mg-HCO3	30.7382688	-23.3576960	6.96	138.90	934.00	56.50	118.10	70.20	5.10	0.00	138.00	47.50	25.80	114.21	0.27	493.69
H14-0180	Mg-HCO3	30.7861868	-23.4197751	7.88	99.10	819.30	82.57	62.75	42.33	1.59	44.91	65.77	22.48	19.89	88.05	0.45	452.97
H14-0181	Mg-HCO3	30.7907146	-23.4427735	7.61	116.50	982.83	91.52	69.88	77.62	0.61	42.74	128.99	14.45	5.00	22.13	0.64	576.36
H14-0183	Mg-HCO3	30.7607970	-23.4460232	7.62	116.80	995.11	92.59	70.61	66.49	1.75	44.30	107.16	27.11	22.94	101.54	0.79	526.98
H14-0184A	Mg-Cl	30.7533802	-23.4488286	8.53	193.00	1239.84	99.30	100.80	132.10	0.92	37.55	306.14	41.24	32.20	142.56	0.75	415.94
H14-0221	Na-Cl	30.5275120	-23.3458909	7.32	225.00	1436.81	137.78	82.80	161.02	1.98	28.72	330.63	26.48	37.92	167.86	0.59	527.35
H14-0233	Mg-HCO3	30.7209349	-23.2990889	6.91	93.20	622.00	64.50	86.80	30.50	2.60	0.00	51.20	9.20	2.50	11.07	0.17	597.46
H14-0237	Na-HCO3	30.6663888	-23.3955552	7.71	116.10	961.24	71.17	51.55	114.75	7.76	33.33	135.40	18.57	12.70	56.22	0.67	505.03
H14-0247	Mg-HCO3	30.7751868	-23.2502034	7.14	93.40	560.00	20.00	87.40	57.50	3.80	0.00	28.30	10.00	0.00	0.00	0.26	589.41
H14-0258	Mg-HCO3	30.7167960	-23.3088937	7.07	65.20	443.00	49.10	46.70	29.50	1.50	0.00	31.20	28.70	4.40	19.48	0.23	354.94
H14-0260	Mg-HCO3	30.5432628	-23.2253714	6.76	98.20	604.00	62.90	57.80	62.10	1.30	0.00	106.70	2.70	22.90	101.37	0.25	348.60
H14-0262	Mg-HCO3	30.5869865	-23.1890129	6.96	116.40	701.00	79.70	62.50	66.30	1.40	0.00	94.00	6.60	22.50	99.60	0.34	500.64
H14-0263	Mg-HCO3	30.5870143	-23.1890129	6.87	185.20	1169.00	114.50	95.70	163.00	2.40	0.00	281.90	23.00	12.10	53.56	0.54	668.18
H14-0264	Mg-HCO3	30.5874032	-23.1882630	7.63	125.10	769.00	82.60	78.60	77.10	2.90	0.00	125.60	9.50	16.70	73.93	0.29	548.69
H14-0265	Mg-HCO3	30.6015148	-23.1848743	7.25	112.20	642.00	49.10	62.70	110.00	2.90	0.00	111.30	4.60	10.60	46.92	0.42	479.43
H14-0267	Mg-HCO3	30.5889588	-23.2034008	6.97	87.90	521.00	72.40	48.10	48.00	1.20	0.00	58.50	12.00	0.00	0.00	0.41	488.82
H14-0272	Mg-HCO3	30.6799615	-23.3145044	7.82	50.10	301.00	26.70	27.30	30.20	1.10	0.00	40.90	4.00	0.00	0.00	0.53	229.96
H14-0273	Mg-HCO3	30.6807115	-23.3156432	7.23	53.20	311.00	34.40	30.40	24.50	3.80	0.00	32.00	1.60	0.90	3.98	0.14	278.49
H14-0276	Mg-HCO3	30.9028295	-23.2041235	6.82	111.00	691.00	85.60	88.90	40.50	3.00	0.00	61.00	4.00	2.40	10.62	0.27	672.44
H14-0277	Mg-HCO3	30.9147744	-23.1894857	6.82	126.20	867.00	89.40	111.50	42.50	3.50	0.00	92.50	5.00	36.20	160.25	0.26	572.83
H14-0280	Na-Cl	30.6968509	-23.2921449	7.18	605.00	3121.00	230.30	170.00	546.00	2.50	0.00	1236.60	12.00	6.90	30.54	0.42	835.22
H14-0281	Mg-HCO3	30.7166015	-23.3160599	7.14	91.00	576.00	57.30	59.60	68.60	3.10	0.00	62.50	34.80	5.70	25.23	0.42	489.79
H14-0283	Na-HCO3	30.8885234	-23.3123660	7.42	267.00	1255.00	75.70	95.10	232.50	5.50	0.00	265.70	17.20	21.80	96.50	0.90	803.76
H14-0284	Mg-HCO3	30.7307686	-23.3217540	7.79	120.80	713.00	49.10	76.60	73.50	5.50	0.03	77.50	21.70	23.30	103.14	0.76	526.37
H14-0286	Mg-HCO3	30.6654332	-23.3229482	7.59	44.00	264.00	23.80	30.90	21.20	1.50	0.00	33.30	4.20	0.00	0.00	0.15	228.25
H14-0293	Mg-HCO3	30.7221017	-23.3195041	7.19	104.00	654.00	60.50	74.60	68.80	5.00	0.00	65.00	34.40	8.90	39.40	0.33	522.96
H14-0297	Mg-HCO3	30.6984065	-23.3094214	7.76	122.30	791.00	74.10	101.40	85.00	3.50	0.00	78.60	8.70	4.20	18.59	0.21	751.82
H14-0299	Mg-HCO3	30.6872395	-23.3140844	7.15	52.20	287.00	29.40	36.32	5.40	0.02	0.00	7.00	7.60	0.00	0.00	0.14	273.49
H14-0319	Mg-HCO3	30.5096700	-23.2815597	7.97	111.90	796.90	79.35	49.08	69.77	0.57	43.16	85.39	48.09	47.07	208.37	0.45	255.71

Borehole nr.	Water type	X	Y	pH	EC	TDS	Ca	Mg	Na	K	Si	Cl	SO4	N	NO3	F	HCO3
H14-0330	Mg-HCO3	30.3867293	-23.3274752	7.59	87.90	708.97	53.30	53.84	62.35	1.13	36.38	70.54	40.16	26.24	116.16	0.89	310.34
H14-0340	Mg-HCO3	30.7123236	-23.2978667	7.74	46.10	306.00	32.00	35.60	23.50	2.50	0.04	45.00	2.50	0.00	0.00	0.14	256.05
H14-0342	Na-Cl	30.6901840	-23.2982555	6.98	1195.00	7349.00	432.50	426.50	1125.00	1.90	0.00	3316.50	10.00	0.00	0.00	0.45	790.59
H14-0344	Mg-HCO3	30.7118514	-23.3113658	7.96	64.50	553.10	41.81	46.49	34.79	0.69	36.95	34.75	27.22	2.93	12.97	0.27	353.95
H14-0345	Mg-HCO3	30.7138792	-23.3120880	6.99	53.20	329.00	37.00	30.60	39.20	0.09	0.00	28.70	34.70	1.50	6.64	0.37	274.95
H14-0352	Mg-HCO3	30.8905757	-23.3126949	7.51	161.90	959.00	71.70	84.50	89.50	4.00	0.00	182.60	31.80	58.40	258.53	0.50	432.73
H14-0370	Na-HCO3	30.7254069	-23.5552935	8.53	237.00	1489.11	50.54	89.77	250.06	22.29	30.27	299.37	31.29	6.91	30.59	0.75	714.14
H14-0411	Mg-HCO3	30.4872599	-23.2782288	7.74	84.90	667.53	58.74	45.52	60.84	1.02	39.13	60.79	31.12	4.68	20.72	0.45	388.22
H14-0415	Na-Cl	30.6548492	-23.3389471	8.07	403.00	2428.28	133.09	153.07	458.18	12.56	25.30	952.03	45.04	42.43	187.82	0.41	485.94
H14-0417	Mg-HCO3	30.6354319	-23.3336974	8.25	223.00	1543.30	117.28	111.19	180.55	7.24	30.58	312.03	40.28	35.34	156.42	0.58	617.70
H14-0447	Mg-HCO3	30.8638800	-23.2252775	8.11	191.00	1400.98	95.59	109.84	143.18	6.58	27.43	198.24	15.24	3.98	17.62	0.40	814.13
H14-0467	Mg-HCO3	30.9185242	-23.3293649	8.00	106.60	1059.34	33.96	143.31	39.34	2.68	36.33	55.30	19.58	3.98	17.62	0.21	747.19
H14-0520	Na-HCO3	30.6579050	-23.3158932	8.01	98.80	815.41	31.14	49.93	114.29	1.88	23.77	73.65	17.91	3.29	14.57	0.47	511.37
H14-0573	Mg-HCO3	30.7288519	-23.3089493	7.68	74.30	509.00	73.70	46.60	46.80	0.80	0.00	38.20	32.00	14.30	63.30	0.63	420.78
H14-0574	Mg-HCO3	30.6697111	-23.3228094	6.77	60.30	391.00	30.60	43.00	37.00	3.60	0.00	66.60	26.60	0.00	0.00	0.53	253.00
H14-0575	Mg-HCO3	30.7365466	-23.3160044	7.62	67.80	477.00	52.00	52.30	41.30	0.90	0.00	37.50	32.50	13.40	59.32	0.38	362.38
H14-0578	Mg-HCO3	30.5766660	-23.2966663	8.05	94.50	762.91	52.57	64.61	45.80	1.91	31.93	44.14	22.33	10.12	44.81	0.59	486.07
H14-0600	Mg-HCO3	30.7273793	-23.3223928	7.32	133.70	714.00	78.50	96.60	17.80	0.80	0.00	30.50	11.70	7.90	34.97	0.18	618.79
H14-0606	Na-HCO3	30.4318015	-23.0655512	7.93	234.00	1415.65	35.91	78.99	269.76	4.24	23.99	269.13	11.09	6.70	29.64	0.49	689.39
H14-0621	Na-Cl	30.6599609	-23.2982555	6.90	319.50	1696.00	105.80	130.20	250.20	12.80	0.00	459.50	98.00	11.60	51.35	0.88	655.86
H14-0626	Mg-Cl	30.6473216	-23.3064493	6.96	966.00	6238.00	366.40	482.00	600.50	13.50	0.00	2324.30	380.00	0.90	3.98	0.55	622.57
H14-0628	Na-Cl	30.6773781	-23.3125879	7.01	426.00	2126.00	94.10	132.50	502.50	7.00	0.00	714.80	19.00	0.00	0.00	2.24	703.54
H14-0632	Mg-HCO3	30.8672448	-23.3854698	7.71	289.00	1393.00	63.10	118.60	213.50	2.00	0.00	260.50	115.00	52.90	234.18	1.65	494.67
H14-0698	Mg-HCO3	30.6581269	-23.3142266	7.92	77.40	575.41	45.46	36.31	56.60	4.57	15.92	86.34	25.99	0.21	0.91	0.24	318.94
H14-0699	Mg-HCO3	30.6343205	-23.3189207	7.94	86.80	693.07	30.53	58.24	73.58	0.93	34.22	70.28	11.70	5.28	23.36	0.28	424.03
H14-0717	Na-Cl	30.6387928	-23.3354196	7.78	523.00	3129.51	229.06	151.61	645.28	8.13	20.63	1360.90	47.89	11.29	49.96	0.61	635.99
H14-0750	Ca-HCO3	30.5303176	-23.3548625	7.90	87.70	697.53	75.48	33.53	58.53	2.95	21.52	61.35	22.38	7.91	35.00	0.42	407.65
H14-0769	Mg-HCO3	30.8513281	-23.1897911	7.93	116.40	934.87	60.65	91.52	40.66	4.40	42.18	69.36	0.03	14.99	66.38	0.25	585.75
H14-0771	Mg-HCO3	30.7994922	-23.6713690	7.57	198.00	1283.76	113.13	93.36	122.52	3.72	39.15	199.23	74.20	59.06	261.45	0.49	415.46
H14-0801	Mg-HCO3	30.3700200	-23.3448800	8.12	101.00	809.14	54.74	54.08	89.32	1.71	34.97	106.00	40.81	23.40	0.00	0.72	358.04
H14-0803	Mg-HCO3	30.7217405	-23.3620290	8.53	173.00	1853.60	19.81	152.53	119.01	1.66	27.40	117.04	55.17	48.05	212.71	0.29	675.25
H14-0821	Na-HCO3	30.7092679	-23.3177820	8.25	215.00	1580.30	93.67	94.66	217.97	3.29	22.85	288.53	35.81	11.57	51.22	0.54	794.01
H14-0822	Mg-HCO3	30.7116847	-23.3170598	8.25	228.00	1388.10	6.57	133.12	183.56	3.39	27.76	291.67	28.89	13.75	60.87	0.39	621.60
H14-0856	Mg-HCO3	30.4062300	-23.3160872	8.14	199.00	1214.07	55.15	103.62	166.25	5.83	26.39	304.23	17.15	3.97	17.57	0.90	543.08
H14-0869	Mg-HCO3	30.7205183	-23.2997833	7.91	93.10	895.38	53.15	92.54	41.13	0.66	35.58	57.22	15.94	1.62	7.17	0.20	627.21
H14-0878	Mg-HCO3	30.6256542	-23.3305865	8.32	144.00	1208.40	55.78	133.83	60.15	1.14	22.83	76.19	8.48	8.81	38.99	0.29	833.51
H14-0886	Mg-HCO3	30.7393521	-23.3244760	8.26	144.00	1456.72	65.83	97.94	87.87	5.23	32.44	99.94	10.47	11.86	52.52	0.32	736.58
H14-0995	Mg-HCO3	30.6096255	-23.3186984	8.15	122.50	974.09	27.13	140.06	24.32	1.41	38.88	89.34	33.71	15.88	70.29	0.20	587.58
H14-0996	Na-HCO3	30.6383765	-23.2985332	8.11	122.10	1026.94	24.45	72.97	160.63	19.74	28.56	157.81	54.31	7.99	35.35	0.96	500.16
H14-0998	Na-HCO3	30.5015938	-23.2820897	7.93	102.20	781.79	42.76	36.16	131.81	2.54	35.75	112.69	67.91	12.21	54.03	0.88	332.87
H14-1003	Mg-Cl	30.7359631	-23.3575293	7.55	428.00	2806.08	134.00	281.53	380.17	4.67	17.23	962.53	247.53	4.14	18.31	0.39	776.33
H14-1007	Mg-HCO3	30.7796867	-23.3315589	7.88	124.60	1002.91	53.86	97.11	58.99	3.59	41.67	66.88	14.44	15.97	70.69	0.60	636.72
H14-1020	Mg-HCO3	30.7417220	-23.3196107	8.16	111.80	966.96	66.22	76.53	76.02	2.28	33.76	65.63	6.02	8.33	36.88	0.39	636.96
H14-1024	Na-HCO3	30.6755163	-23.3976653	7.77	112.30	872.65	61.66	49.53	105.66	5.42	34.34	99.58	38.89	14.34	63.46	0.46	447.82

Borehole nr.	Water type	X	Y	pH	EC	TDS	Ca	Mg	Na	K	Si	Cl	SO4	N	NO3	F	HCO3
H14-1027	Na-Cl	30.4967046	-23.3515015	7.99	326.00	1921.74	27.23	110.70	370.52	2.67	29.55	645.70	40.96	43.43	192.26	0.71	530.88
H14-1029	Na-Cl	30.6918223	-23.5698480	8.21	230.00	1628.20	12.71	64.97	403.34	2.68	38.99	409.35	36.72	1.67	7.41	0.83	690.12
H14-1030	Na-HCO3	30.6381543	-23.2991998	8.38	180.00	1326.97	57.74	88.02	188.60	16.11	38.66	205.75	45.77	14.80	65.49	1.01	658.42
H14-1031	Mg-HCO3	30.5590683	-23.2158999	8.38	113.40	832.41	80.39	59.74	58.41	4.92	38.75	105.30	19.43	27.51	121.76	0.31	382.07
H14-1032	Mg-HCO3	30.5162617	-23.2839507	8.16	124.10	891.62	86.39	62.86	74.45	1.71	37.12	118.68	24.78	35.23	155.97	0.54	366.08
H14-1035	Mg-Cl	30.5721520	-23.2855895	8.30	361.00	1889.98	41.97	280.20	178.18	15.89	20.28	1015.02	35.05	39.73	175.89	0.28	147.24
H14-1036	Na-HCO3	30.5822911	-23.3772221	7.88	98.00	561.87	26.42	37.97	80.12	4.99	35.41	111.20	26.66	4.13	18.30	0.68	255.48
H14-1041	Mg-Cl	30.7339073	-23.3575848	8.14	413.00	2602.39	65.13	382.97	235.50	2.01	5.16	545.80	185.51	158.72	702.62	0.39	477.72
H14-1088	Ca-Cl	30.8832170	-23.6600365	7.81	285.00	1813.61	215.58	122.99	180.56	3.46	39.08	379.04	125.37	78.77	348.70	0.42	437.33
H15-0002	Mg-HCO3	30.4841670	-23.0900000	8.05	94.40	711.00	41.60	45.30	75.60	0.96	3.29	68.50	21.90	10.64	0.00	0.59	402.86
H15-0003	Mg-HCO3	30.4955560	-23.1233330	8.33	79.00	554.08	49.90	37.27	42.89	3.41	32.66	64.24	3.00	20.51	0.00	0.29	262.26
H15-0004B	Mg-HCO3	30.4927780	-23.1261110	8.17	59.00	548.00	46.80	37.80	46.50	2.66	5.82	33.20	5.60	8.54	0.00	0.31	337.62
H15-0006	Mg-HCO3	30.5194440	-23.1280560	7.99	53.60	485.00	25.80	38.40	41.80	3.31	32.75	9.70	4.90	0.63	0.00	0.26	358.47
H15-0008	Mg-HCO3	30.5266670	-23.1261110	8.36	83.20	588.00	43.20	45.60	62.60	2.66	5.63	121.90	9.90	11.02	0.00	0.28	253.00
H15-0028	Mg-HCO3	30.7126300	-22.9244500	8.27	97.80	843.54	52.42	57.38	63.61	1.28	35.49	69.37	19.05	41.19	0.00	0.39	397.63
H15-0033	Ca-HCO3	30.7195700	-22.8760400	8.22	84.70	637.48	89.91	41.80	27.20	0.34	20.86	68.37	11.10	13.45	0.00	0.14	338.58
H15-0034	Ca-HCO3	30.7225100	-22.8743900	8.07	98.10	744.62	88.92	51.04	29.50	0.49	14.81	71.07	10.12	23.03	0.00	0.22	389.07
H15-0097	Na-HCO3	30.6463890	-23.0269440	8.11	155.00	1113.83	78.47	59.06	142.93	2.36	30.28	153.64	11.04	22.25	0.00	0.75	566.97
H15-0112	Mg-HCO3	30.7369400	-23.0108600	8.06	179.00	1269.75	113.97	102.48	104.13	1.75	38.26	186.73	238.20	0.80	0.00	0.47	518.32
H15-0185	Ca-HCO3	30.7654600	-22.8838200	8.46	84.20	667.48	85.75	48.14	27.25	0.46	28.46	53.12	7.06	5.94	0.00	0.29	419.07
H15-0195	Ca-HCO3	30.7244900	-22.8975400	8.10	88.90	681.89	74.70	42.06	55.71	0.93	26.93	69.36	11.55	13.91	0.00	0.31	365.53
H15-0198	Mg-HCO3	30.6925000	-22.9378400	7.94	108.50	958.26	82.32	65.94	69.49	6.65	29.72	65.76	4.59	4.10	0.00	0.31	645.01
H15-0199	Mg-HCO3	30.6805700	-22.9594700	8.09	169.00	1128.05	50.17	76.77	94.41	1.10	30.04	116.36	28.37	51.37	0.00	0.40	532.83
H15-0201	Mg-HCO3	30.6869800	-22.9723700	7.95	24.30	160.33	15.68	9.65	10.78	1.81	7.92	20.11	2.00	0.13	0.00	0.14	99.51
H15-0203	Mg-HCO3	30.6486000	-22.9530900	8.33	64.30	495.79	36.62	30.44	50.72	0.15	32.28	34.33	4.38	0.08	0.00	1.07	337.65
H15-0205	Mg-HCO3	30.6628200	-22.9625400	8.23	194.00	1292.77	152.45	92.89	89.45	0.39	37.64	269.37	12.58	37.95	0.00	0.40	507.23
H15-0213	Mg-HCO3	30.5627780	-23.0588890	8.57	139.00	1049.00	67.60	71.90	111.50	5.08	32.15	142.40	31.40	30.19	0.00	0.35	485.40
H15-0216	Na-HCO3	30.5503000	-23.0664400	8.68	78.10	673.23	43.55	25.43	94.22	0.63	22.60	26.89	9.50	5.14	0.00	0.41	449.75
H15-0220	Mg-HCO3	30.6491900	-23.0119100	8.62	81.80	742.59	48.01	59.84	54.60	4.89	37.05	9.71	10.51	1.11	0.00	0.47	549.54
H15-0242	Mg-HCO3	30.6305000	-22.9778600	8.48	78.30	663.43	61.73	40.38	57.69	0.77	33.45	36.22	13.75	7.96	0.00	0.49	417.12
H15-0334	Na-HCO3	30.6413890	-22.9805560	8.35	92.30	800.95	59.56	45.65	86.60	1.33	23.67	43.88	5.12	0.22	0.00	0.57	557.22
H15-0335	Na-HCO3	30.6113900	-23.0497200	7.62	47.20	363.79	23.47	16.32	50.54	0.51	13.99	28.80	7.22	0.02	0.00	0.25	236.54
H15-0433	Ca-HCO3	30.6486100	-23.0029700	8.40	85.50	678.48	96.97	31.50	38.63	12.78	16.02	63.26	31.07	2.78	0.00	0.48	391.20
H15-0449	Mg-HCO3	30.6980100	-22.9946100	8.33	80.20	595.76	52.20	39.12	53.07	2.39	35.56	63.47	10.83	8.77	0.00	0.33	335.47
H15-0468	Na-HCO3	30.5489600	-23.0808600	8.00	70.80	554.06	38.02	26.83	74.76	1.47	23.54	49.80	14.54	1.81	0.00	0.37	340.20
H15-0645	Mg-HCO3	30.6298600	-23.0060000	7.28	102.90	732.28	75.65	50.27	66.59	0.67	33.18	140.12	10.45	15.59	0.00	0.50	318.97
H15-0648	Mg-HCO3	30.7302100	-22.8862400	7.57	84.40	599.79	60.89	38.35	42.72	1.92	23.12	61.30	11.44	20.51	0.00	0.24	291.86
H15-0659	Mg-HCO3	30.6422700	-23.0002200	8.32	93.70	834.93	47.78	73.96	74.26	0.76	28.59	74.83	3.00	2.37	0.00	0.40	549.42
H15-0673	Mg-HCO3	30.6814700	-22.9349200	8.21	98.60	769.69	71.79	51.86	51.75	4.19	30.79	78.64	20.86	24.27	0.00	0.50	382.58
H15-0734	Mg-HCO3	30.5603000	-23.0726100	8.46	66.40	512.22	33.77	38.68	46.59	9.51	25.38	54.22	16.78	8.94	0.00	0.32	272.72
H15-0738	Mg-HCO3	30.6441600	-22.9981600	8.37	77.50	691.34	58.41	43.41	59.27	0.97	22.46	34.76	6.29	1.31	0.00	0.43	481.98
H16-0205	Na-HCO3	29.9379327	-23.4995003	7.90	18.30	143.97	11.63	6.00	14.63	2.60	28.22	10.00	13.37	0.58	2.57	0.14	87.90
H16-0206	Na-HCO3	29.9378527	-23.4990304	7.60	14.20	111.37	9.02	4.09	12.68	1.49	27.42	10.00	11.79	1.17	5.18	0.12	61.83
H16-0340	Ca-HCO3	29.9441174	-23.4992404	6.83	12.10	77.00	12.40	5.10	10.10	0.40	0.00	8.20	1.50	3.99	17.66	0.18	54.99

Borehole nr.	Water type	X	Y	pH	EC	TDS	Ca	Mg	Na	K	Si	Cl	SO4	N	NO3	F	HCO3
H16-0342	Na-HCO3	29.9418229	-23.5000403	8.08	18.70	134.96	11.53	5.54	17.76	1.10	33.03	10.00	4.00	0.31	1.37	0.16	90.18
H17-0001	Mg-HCO3	30.0700000	-23.1705560	7.48	19.60	145.77	10.46	12.67	7.95	1.21	27.95	10.52	2.00	2.26	0.00	0.16	90.70
H17-0005	Mg-HCO3	30.0669438	-23.1614339	8.00	107.00	637.00	39.00	88.00	48.00	2.00	0.00	78.00	6.00	7.00	30.99	0.00	420.66
H17-0009	Mg-HCO3	30.0660517	-23.1617039	7.00	44.00	269.00	24.00	36.00	14.00	1.00	0.00	15.00	1.00	3.00	13.28	0.00	249.96
H17-0010	Mg-HCO3	30.0669438	-23.1593741	7.00	46.00	280.00	35.00	29.00	32.00	2.00	0.00	29.00	7.00	2.00	8.85	0.00	271.90
H17-0013	Mg-HCO3	30.0547160	-23.1557643	7.00	48.00	293.00	23.00	41.00	17.00	2.00	0.00	31.00	4.00	5.00	22.13	0.00	237.76
H17-0015	Mg-HCO3	30.0697000	-23.1686600	7.60	27.10	211.62	17.07	17.91	8.04	1.57	31.60	15.22	7.07	2.83	0.00	0.18	131.90
H17-0017	Mg-HCO3	30.0700918	-23.1704133	7.56	22.90	174.60	12.89	15.11	8.44	2.32	26.07	11.92	5.23	1.87	8.26	0.17	110.13
H17-0018	Mg-HCO3	30.0866670	-23.1700000	8.17	21.20	155.00	9.00	11.60	10.00	1.60	20.85	5.10	2.00	1.15	0.00	0.13	110.59
H17-0020	Mg-HCO3	30.0771700	-23.1689200	7.29	19.50	162.26	12.74	12.88	7.84	0.94	24.26	5.00	7.20	1.74	0.00	0.19	107.59
H17-0021	Mg-HCO3	30.0846922	-23.1745231	7.00	20.00	124.00	13.00	13.00	16.00	1.00	0.00	6.00	3.00	1.00	4.43	0.00	112.18
H17-0021B	Mg-HCO3	30.0850400	-23.1737700	7.61	23.00	168.97	13.15	12.53	10.41	1.59	24.36	12.08	4.24	1.50	0.00	0.16	107.91
H17-0022	Mg-HCO3	30.0817422	-23.1789728	6.00	24.00	148.00	15.00	21.00	4.00	1.00	0.00	5.00	2.00	1.00	4.43	0.00	148.75
H17-0023	Mg-HCO3	30.0994700	-23.1787600	7.78	15.90	132.04	9.93	9.45	7.50	1.53	24.48	5.00	5.37	2.27	0.00	0.16	82.85
H17-0026	Mg-HCO3	30.0585700	-23.1634900	8.09	48.60	399.41	22.31	46.39	9.48	3.30	33.01	23.54	9.61	5.62	0.00	0.17	259.54
H17-0027	Mg-HCO3	30.0662417	-23.1665036	7.00	75.00	531.00	54.00	68.00	39.00	3.00	0.00	34.00	29.00	6.00	26.56	0.00	476.75
H17-0036	Mg-HCO3	30.0571700	-23.1881400	7.91	9.78	73.31	4.42	5.27	4.45	1.74	13.98	5.00	5.85	1.02	0.00	0.16	41.59
H17-0042	Mg-HCO3	30.0595300	-23.1957800	6.77	10.09	77.70	4.98	5.47	4.39	2.20	15.28	5.00	7.92	1.25	0.00	0.14	41.85
H17-0044	Mg-HCO3	30.0617300	-23.1792900	7.91	17.10	132.74	7.94	11.03	7.10	2.23	22.47	5.00	6.86	0.88	0.00	0.14	88.41
H17-0045	Mg-HCO3	30.0442900	-23.1779700	7.63	25.00	190.24	18.94	12.87	10.35	1.11	27.21	20.64	9.81	6.47	0.00	0.15	87.60
H17-0047	Mg-HCO3	30.0438890	-23.1794440	7.67	18.00	136.00	9.70	7.40	10.80	1.10	24.89	5.10	2.00	0.75	0.00	0.10	95.72
H17-0051	Mg-HCO3	30.0791614	-23.1729854	7.00	47.00	272.00	28.00	27.00	30.00	2.00	0.00	16.00	5.00	2.00	8.85	1.00	263.37
H17-0053	Mg-HCO3	30.0841670	-23.1477780	8.01	35.10	303.61	25.16	27.03	14.65	1.78	28.90	17.94	10.54	2.07	0.00	0.29	196.97
H17-0058	Mg-HCO3	30.0719400	-23.1397000	8.09	52.40	406.39	38.73	30.19	24.20	2.66	23.19	18.50	8.45	3.47	0.00	0.26	267.97
H17-0062	Mg-HCO3	30.0523300	-23.1397700	7.42	67.80	452.83	43.97	36.88	26.26	1.65	9.29	81.20	24.82	8.81	0.00	0.16	198.29
H17-0072	Mg-HCO3	30.2031400	-23.1450500	8.04	29.90	210.20	19.64	14.73	11.06	1.56	32.12	12.52	4.09	2.14	0.00	0.29	136.72
H17-0080	Mg-HCO3	30.0852729	-23.1702078	7.00	30.00	207.00	25.00	20.00	27.00	2.00	0.00	16.00	8.00	0.00	0.00	0.00	215.82
H17-0081	Mg-HCO3	30.0846323	-23.1709533	6.00	18.00	120.00	13.00	12.00	17.00	1.00	0.00	10.00	7.00	1.00	4.43	0.00	115.83
H17-0082	Mg-HCO3	30.0900624	-23.1731032	7.00	32.00	215.00	17.00	29.00	26.00	3.00	0.00	15.00	6.00	2.00	8.85	0.00	230.45
H17-0083	Mg-HCO3	30.0401309	-23.1770528	7.00	31.00	190.00	20.00	20.00	27.00	2.00	0.00	20.00	10.00	1.00	4.43	0.00	181.68
H17-0084	Mg-HCO3	30.0481312	-23.1620639	7.00	40.00	259.00	25.00	31.00	24.00	3.00	0.00	21.00	11.00	3.00	13.28	0.00	236.54
H17-0085	Mg-HCO3	30.1034600	-23.1998100	8.17	51.80	437.44	34.99	41.16	18.22	1.74	28.73	30.13	10.60	4.28	0.00	0.27	281.25
H17-0092	Mg-HCO3	30.1402780	-23.1963890	7.88	54.90	422.13	20.69	52.50	11.81	2.56	34.82	36.16	8.65	15.01	0.00	0.18	222.77
H17-0103	Mg-HCO3	30.2070100	-23.2023000	7.91	57.00	274.00	25.60	41.90	21.10	3.30	22.70	34.00	6.30	4.77	21.10	0.20	202.90
H17-0103	Mg-HCO3	30.2069440	-23.2016670	8.61	50.40	387.00	22.20	36.90	19.30	3.21	32.90	20.40	4.60	3.82	0.00	0.23	263.49
H17-0107	Mg-HCO3	30.2255560	-23.2363890	8.54	99.60	783.00	61.40	60.90	55.20	4.00	21.19	86.30	27.00	28.87	0.00	0.66	359.21
H17-0113	Mg-HCO3	30.2875032	-23.2713167	8.10	60.70	545.00	30.00	41.00	49.00	3.40	36.80	20.00	9.00	1.10	4.87	0.20	386.52
H17-0116	Mg-HCO3	30.2842800	-23.2773100	8.33	87.00	704.83	45.92	55.59	59.72	5.21	29.56	56.28	14.02	6.73	0.00	0.28	437.96
H17-0119	Mg-HCO3	30.2556200	-23.2619700	8.02	82.80	631.24	34.22	53.78	51.96	7.19	33.23	67.64	23.47	19.75	0.00	0.34	305.15
H17-0120	Mg-HCO3	30.1725900	-23.2339200	8.66	64.00	420.00	34.30	47.50	28.10	3.80	20.40	38.00	8.50	11.39	50.40	0.10	225.80
H17-0126	Mg-HCO3	30.1220832	-23.2282894	8.06	44.40	331.12	19.46	31.16	16.33	3.27	31.36	23.19	13.28	4.06	17.98	0.18	206.19
H17-0132	Mg-HCO3	30.0798900	-23.2318300	7.82	65.80	525.11	33.05	59.32	17.22	5.70	33.14	46.78	14.68	14.24	0.00	0.19	284.94
H17-0133	Mg-HCO3	30.0818800	-23.2368300	7.86	67.20	522.84	32.58	53.77	24.09	5.58	24.47	61.10	16.43	12.46	0.00	0.19	273.78
H17-0141	Mg-HCO3	30.2042400	-23.1150500	7.63	20.40	128.29	9.14	9.31	8.75	1.41	29.03	5.00	2.00	1.90	0.00	0.25	83.77

Borehole nr.	Water type	X	Y	pH	EC	TDS	Ca	Mg	Na	K	Si	Cl	SO4	N	NO3	F	HCO3
H17-0150	Mg-HCO3	30.1123000	-23.2519000	7.73	72.10	633.99	38.02	66.35	28.91	8.81	30.96	49.83	17.64	8.52	0.00	0.24	386.33
H17-0153	Mg-HCO3	30.0427510	-23.1750030	7.00	35.00	237.00	25.00	26.00	28.00	2.00	0.00	24.00	8.00	3.00	13.28	0.00	220.69
H17-0155	Mg-HCO3	30.0377709	-23.1765828	7.00	28.00	174.00	19.00	17.00	25.00	2.00	0.00	20.00	6.00	0.00	0.00	0.00	174.36
H17-0156	Mg-HCO3	30.0516660	-23.1560830	7.00	48.00	288.00	32.00	26.00	32.00	2.00	0.00	30.00	10.00	8.00	35.41	0.00	206.06
H170159	Mg-HCO3	30.2750000	-23.1866670	8.42	60.60	473.92	25.66	35.84	42.05	3.67	24.27	37.41	12.97	1.34	0.00	0.45	309.86
H17-0160	Mg-HCO3	30.1365100	-23.2600300	7.56	68.70	505.51	47.81	36.82	26.04	3.83	27.91	48.19	25.82	15.33	0.00	0.25	248.44
H17-0163	Mg-HCO3	30.1625400	-23.2674400	7.87	53.50	373.94	27.45	30.19	24.54	2.82	16.90	44.98	16.58	2.26	0.00	0.22	217.12
H17-0169	Mg-HCO3	30.2449800	-23.1572800	7.57	52.30	373.10	24.24	32.05	17.24	5.44	28.67	20.98	4.82	6.84	0.00	0.26	237.70
H17-0171	Mg-HCO3	30.2417000	-23.1591600	7.99	45.00	329.09	19.79	28.29	16.36	5.06	27.28	14.65	5.46	0.91	0.00	0.27	235.06
H17-0172	Mg-HCO3	30.2571300	-23.1641000	7.74	53.70	371.51	24.83	32.90	21.55	4.82	31.41	26.65	6.29	4.71	0.00	0.29	233.31
H17-0177	Mg-HCO3	30.3541700	-23.1680200	8.42	47.70	354.23	25.06	31.29	17.12	4.94	28.15	25.78	6.80	8.57	0.00	0.29	204.86
H17-0178	Mg-HCO3	30.2060800	-23.1732200	7.93	56.30	398.21	19.70	40.64	15.89	5.39	27.93	24.51	6.81	3.81	0.00	0.32	267.97
H17-0179	Mg-HCO3	30.1772800	-23.1810900	7.75	48.00	308.00	23.50	34.10	16.70	2.60	20.80	30.50	3.50	10.50	46.50	0.20	137.00
H17-0180	Mg-HCO3	30.1827700	-23.1863700	7.78	61.00	414.00	22.00	48.50	17.40	3.40	22.00	38.20	6.20	16.02	70.90	0.05	166.10
H17-0185	Mg-HCO3	30.2356300	-23.1622200	7.95	62.60	398.40	23.68	38.78	17.95	6.15	28.60	35.32	5.53	9.04	0.00	0.23	230.66
H17-0187	Mg-HCO3	30.2667000	-23.1955900	7.89	65.30	428.82	35.81	36.33	25.45	3.89	20.25	62.39	20.44	5.97	0.00	0.20	217.83
H17-0189	Mg-HCO3	30.2545600	-23.1910400	8.32	59.90	477.39	38.36	33.62	31.09	2.91	8.73	30.31	6.41	0.07	0.00	0.25	333.93
H17-0205	Ca-Cl	29.9727847	-23.2779757	7.40	413.00	2524.66	413.00	21.44	472.43	3.89	12.04	765.91	711.26	6.06	26.83	0.94	166.81
H17-0214	Mg-HCO3	30.2205500	-23.1194400	8.04	28.20	197.33	13.34	15.25	11.45	2.06	28.41	11.29	2.00	1.15	0.00	0.24	136.46
H17-0215	Ca-HCO3	30.1772300	-23.1079600	7.74	25.10	171.49	18.66	8.35	9.74	1.28	27.59	11.54	6.09	4.17	0.00	0.27	97.00
H17-0215B	Mg-HCO3	30.1769440	-23.1086110	8.22	20.90	161.00	11.10	10.00	11.10	1.29	23.81	5.40	6.20	1.17	0.00	0.13	110.96
H17-0219	Mg-Cl	29.9763638	-23.2955323	8.02	123.80	825.13	65.51	76.09	59.78	3.15	20.98	145.14	37.15	53.38	236.28	0.45	201.36
H17-0220	Ca-HCO3	29.9824196	-23.2973655	8.00	44.90	339.90	30.33	17.00	32.04	3.97	17.90	21.14	6.99	4.49	19.89	0.10	208.43
H17-0222	Mg-HCO3	29.9795028	-23.2935046	7.91	117.60	828.15	52.24	61.34	94.45	8.49	14.51	128.32	53.12	35.93	159.07	0.32	270.59
H17-0224	Mg-HCO3	29.9950656	-23.2871162	7.41	32.70	190.28	7.93	15.04	20.39	2.69	14.19	25.07	12.27	9.28	41.06	0.20	65.10
H17-0226	Na-NO3	30.0192695	-23.2759226	7.50	29.20	178.82	9.16	3.15	38.28	0.95	28.72	28.33	6.00	13.71	60.69	0.20	34.96
H17-0237	Mg-HCO3	30.0472709	-23.2598126	7.64	19.00	145.45	11.28	9.09	11.05	1.26	28.76	8.35	6.00	0.54	2.41	0.20	98.80
H170242	Mg-HCO3	30.2263890	-23.1886110	8.07	57.60	421.85	28.74	40.09	23.59	4.92	19.90	38.00	11.15	0.34	0.00	0.43	273.20
H17-0245	Na-HCO3	30.3386000	-23.2229900	8.11	73.20	489.67	29.23	24.82	71.37	4.86	8.49	86.80	32.90	12.52	0.00	0.45	183.42
H17-0255	Mg-HCO3	30.3773500	-23.2475300	8.18	104.60	829.82	61.70	64.52	57.23	7.42	43.83	61.08	28.98	23.70	0.00	0.95	442.96
H17-0279	Ca-HCO3	30.2445572	-23.2993936	7.86	90.60	635.72	79.13	35.58	42.67	4.01	19.83	70.63	42.87	33.55	148.51	0.32	211.90
H17-0280	Mg-HCO3	30.2422220	-23.2863890	7.46	62.90	599.00	60.80	41.70	41.80	0.87	26.36	67.40	5.30	14.68	0.00	0.40	315.68
H17-0285	Mg-HCO3	30.1024978	-23.3113136	8.30	80.00	590.00	49.00	44.00	42.00	9.60	19.50	54.00	20.00	29.31	129.75	0.29	241.42
H17-0286	Mg-HCO3	30.0936000	-23.3116697	8.70	82.40	641.00	52.00	49.00	46.00	7.10	18.00	51.00	13.00	20.11	89.02	0.20	332.87
H17-0287	Mg-HCO3	30.1063880	-23.3104737	7.70	45.00	304.00	29.00	18.00	27.00	1.60	17.30	35.00	10.00	15.59	69.01	0.18	114.61
H17-0291A	Mg-HCO3	30.1171900	-23.3141400	7.73	77.30	594.36	43.26	55.72	30.45	7.80	31.81	73.33	20.12	15.89	0.00	0.22	292.89
H17-0294	Mg-HCO3	30.1201800	-23.3098800	7.61	60.80	512.83	40.41	43.65	25.04	7.55	27.93	44.80	17.09	14.13	0.00	0.21	271.37
H17-0300	Na-HCO3	30.0296203	-23.3244426	7.25	19.50	138.10	13.08	5.62	15.37	1.09	28.86	10.50	3.00	3.79	16.77	0.10	72.37
H17-0303	Mg-NO3	30.0533100	-23.2905597	7.00	39.20	424.00	15.00	18.00	23.00	5.20	22.10	37.00	14.00	16.96	75.08	0.14	54.87
H17-0304	Mg-HCO3	30.0522155	-23.2951946	8.30	48.50	390.00	17.00	37.00	29.00	8.20	31.30	23.00	4.00	1.65	7.30	0.21	264.59
H17-0308	Mg-HCO3	30.0880472	-23.2879752	8.00	55.20	418.00	29.00	33.00	32.00	6.20	26.50	37.00	11.00	2.76	12.22	0.29	257.27
H17-0309	Mg-HCO3	30.0874971	-23.2940848	8.00	51.60	408.00	20.00	36.00	31.00	9.10	27.30	30.00	11.00	0.06	0.27	0.20	270.68
H17-0310A	Mg-HCO3	30.0661061	-23.3357519	8.50	67.80	480.00	40.00	30.00	55.00	1.40	15.90	68.00	63.00	0.61	2.70	0.58	218.25
H17-0311	Mg-HCO3	30.0666560	-23.3488110	8.06	60.90	458.12	42.78	31.53	30.75	3.77	20.90	38.67	33.76	4.98	22.05	0.24	254.54

Borehole nr.	Water type	X	Y	pH	EC	TDS	Ca	Mg	Na	K	Si	Cl	SO4	N	NO3	F	HCO3
H17-0320	Mg-HCO3	30.0024900	-23.2916697	7.20	35.30	233.10	10.28	17.70	21.84	5.72	25.18	25.46	7.86	7.25	32.11	0.10	111.96
H17-0329	Ca-HCO3	29.9935800	-23.3455700	8.02	44.70	308.32	29.27	16.29	24.54	2.98	19.31	21.90	4.58	3.40	0.00	0.28	193.31
H17-0345	Mg-HCO3	29.9533080	-23.3594800	7.84	86.50	675.00	42.80	47.46	68.55	6.98	24.16	58.86	15.29	7.07	31.29	0.23	403.43
H17-0350	Mg-HCO3	29.9377075	-23.3732491	8.35	87.10	684.32	43.34	63.55	47.44	5.18	24.52	69.08	16.96	17.54	77.65	0.16	361.01
H17-0352	Mg-HCO3	29.9236270	-23.4010371	7.81	68.00	477.19	30.05	35.89	42.23	12.23	24.38	53.38	16.61	14.10	62.40	0.15	224.16
H17-0358	Mg-HCO3	30.2100200	-23.2608900	7.87	85.20	733.24	47.62	72.93	29.91	8.63	36.25	62.47	7.62	3.57	0.00	0.28	487.84
H17-0366	Mg-HCO3	30.1873300	-23.1763700	7.69	39.60	268.11	18.53	20.44	15.16	2.48	30.80	13.63	5.11	1.32	0.00	0.33	186.44
H17-0393	Mg-HCO3	30.0511400	-23.1513600	7.90	72.80	584.87	54.12	50.56	28.11	1.81	17.12	57.07	15.96	18.90	0.00	0.25	293.23
H17-0395	Mg-HCO3	30.0600900	-23.1677500	7.17	34.20	287.25	25.58	25.30	8.96	1.09	31.91	18.07	10.44	3.01	0.00	0.16	184.14
H17-0406	Mg-HCO3	30.1794381	-23.0999384	7.54	39.50	230.00	22.19	16.58	17.91	2.91	22.70	48.77	4.00	3.35	14.83	0.21	104.57
H17-0408	Mg-HCO3	30.0993568	-23.1999002	7.99	46.60	329.88	23.80	29.05	15.26	1.60	32.65	27.15	6.00	9.85	43.60	0.37	186.00
H17-0409	Mg-HCO3	30.0953200	-23.2000100	8.00	54.60	428.81	40.01	37.46	15.97	1.94	35.63	39.57	8.02	9.26	0.00	0.22	244.42
H17-0412	Mg-HCO3	30.2255200	-23.1673600	7.90	57.40	396.31	23.94	37.78	17.94	5.65	29.21	35.20	5.40	8.83	0.00	0.23	231.03
H17-0413	Mg-HCO3	30.2955559	-23.2818660	8.18	76.50	610.99	28.34	39.68	74.80	5.24	15.41	30.22	9.42	2.97	13.15	0.36	409.45
H17-0415	Mg-HCO3	30.2438883	-23.2747564	7.67	111.40	770.84	76.15	52.19	68.11	2.18	25.54	99.93	36.12	43.58	192.92	0.38	242.69
H17-0420	Na-HCO3	30.3437900	-23.2302400	8.68	65.00	360.00	34.90	26.70	59.70	3.60	10.00	52.30	13.20	5.78	25.60	0.30	215.40
H17-0420	Na-HCO3	30.3437800	-23.2302297	7.65	80.90	619.21	24.21	25.25	114.61	2.20	6.90	69.36	12.25	0.04	0.18	0.55	370.59
H17-0451	Na-HCO3	30.0185700	-23.2765397	7.29	22.50	181.14	12.14	7.01	20.84	1.98	30.03	13.30	5.45	7.32	32.40	0.17	87.58
H17-0454	Mg-HCO3	29.9855586	-23.3020874	8.34	67.50	562.30	5.68	79.89	11.52	4.36	38.86	19.84	8.24	7.21	31.92	0.11	400.56
H17-0516	Mg-HCO3	30.1563400	-23.1896400	7.92	46.00	338.77	18.48	42.22	10.75	2.78	31.10	18.37	2.00	5.86	0.00	0.19	217.92
H17-0528	Mg-HCO3	29.9870600	-23.2126200	8.06	25.50	189.91	8.79	19.27	8.22	1.79	26.70	5.00	5.37	1.80	0.00	0.13	133.32
H17-0529	Mg-HCO3	29.9794700	-23.2108400	8.30	30.30	226.02	9.42	25.86	8.30	1.74	25.96	5.00	4.92	2.09	0.00	0.11	161.37
H17-0534	Mg-HCO3	30.0516000	-23.2107000	7.95	23.10	171.06	15.85	11.75	7.71	3.47	23.05	5.00	5.36	1.42	0.00	0.12	115.36
H17-0550	Mg-HCO3	29.9590300	-23.2210600	8.19	40.60	295.58	16.77	27.35	18.01	1.74	29.05	20.83	5.09	4.82	0.00	0.13	184.26
H17-0552	Na-HCO3	29.9736100	-23.2173700	7.14	15.30	114.98	6.21	5.81	11.97	1.83	23.96	7.89	8.36	1.03	0.00	0.10	68.21
H17-0612	Mg-HCO3	30.1623700	-23.2682400	8.56	52.00	304.00	28.80	32.60	26.90	3.00	13.50	42.20	17.10	2.80	12.40	0.20	170.10
H17-0654	Mg-HCO3	30.1865400	-23.2016400	7.51	73.00	376.00	36.80	49.30	25.10	3.20	20.10	55.60	22.60	23.06	102.10	0.20	152.80
H17-0670	Mg-HCO3	30.1729800	-23.2330900	8.23	70.40	522.74	33.98	49.80	22.41	4.87	30.29	36.85	8.34	10.16	0.00	0.17	321.32
H17-0671	Mg-HCO3	30.1420500	-23.2446300	8.23	91.30	762.26	48.41	74.72	59.03	2.87	24.61	96.74	22.06	4.90	0.00	0.24	436.22
H17-0773	Mg-HCO3	30.2693641	-23.1629864	8.15	87.40	674.15	41.19	66.56	29.23	14.01	33.29	64.85	16.80	44.90	198.75	0.49	239.15
H17-0775	Mg-HCO3	30.2794200	-23.1880958	7.66	73.70	603.07	48.64	51.75	33.61	1.75	21.80	57.75	13.08	12.93	57.22	0.52	338.68
H17-0776	Mg-HCO3	30.2805842	-23.2375924	7.94	88.60	741.37	41.14	65.52	51.30	10.84	27.99	59.73	10.11	26.04	115.28	0.44	386.85
H17-0777	Mg-HCO3	30.0940184	-23.1999835	7.73	49.60	381.55	32.09	33.13	16.69	1.26	35.79	34.49	8.41	8.22	36.38	0.28	218.72
H17-0778	Mg-NO3	30.1396557	-23.2626182	7.46	143.00	1024.89	127.11	81.82	35.89	9.33	21.88	156.52	46.81	66.20	293.07	0.35	273.83
H17-0779	Mg-HCO3	30.3326998	-23.2070390	8.23	84.10	757.31	58.14	69.00	36.84	3.42	29.27	36.09	10.46	10.98	48.60	1.17	493.45
H17-0781	Mg-HCO3	30.0887680	-23.2285371	7.80	70.40	556.87	33.74	59.20	26.46	3.50	28.55	69.88	6.39	7.05	31.19	0.29	326.04
H17-0792	Na-HCO3	29.9950300	-23.2159000	7.71	12.46	95.70	5.80	4.20	10.59	1.47	26.17	5.47	7.75	1.39	0.00	0.36	53.61
H17-0969	Mg-HCO3	30.0634400	-23.1824700	7.96	11.13	90.26	7.42	4.79	6.20	1.14	20.46	5.80	2.00	0.51	0.00	0.12	60.43
H17-0970	Mg-HCO3	29.9902700	-23.1992900	8.34	42.90	266.44	23.63	24.29	15.26	0.97	26.47	33.75	4.26	2.09	0.00	0.12	154.81
H17-0980	Mg-HCO3	29.9507300	-23.2205400	8.30	27.00	189.29	8.56	12.52	21.53	3.37	37.20	14.33	2.00	1.01	0.00	0.13	122.29
H17-0981	Mg-HCO3	29.9950000	-23.1904500	8.07	32.10	224.21	19.32	15.26	17.64	0.97	30.49	11.64	4.14	1.07	0.00	0.11	150.24
H17-0982	Mg-HCO3	30.0534100	-23.1561600	8.08	54.70	420.82	29.02	28.41	39.76	1.08	15.43	19.29	9.07	4.85	0.00	0.21	272.41
H17-School00	Na-HCO3	30.3668400	-23.2478500	8.62	135.00	866.00	52.70	62.10	166.00	5.20	25.60	159.50	37.30	22.54	99.80	0.60	366.00
H17-School00	Na-Cl	30.3416300	-23.2248000	8.63	197.00	1292.00	62.80	96.40	235.00	1.30	21.50	362.60	33.10	23.63	104.60	0.80	494.00

Borehole nr.	Water type	X	Y	pH	EC	TDS	Ca	Mg	Na	K	Si	Cl	SO4	N	NO3	F	HCO3
H20-0001	Ca-NO3	30.5908473	-22.8605058	8.00	104.40	710.00	98.00	46.00	23.00	1.10	22.30	80.00	13.00	58.36	258.35	0.10	191.43
H20-0003	Na-HCO3	30.5952966	-22.8588459	8.10	62.40	453.00	45.00	21.00	64.00	1.60	15.40	64.00	5.00	0.21	0.93	0.20	267.03
H20-0004	Mg-HCO3	30.6147337	-22.8624554	8.40	54.90	478.00	55.00	34.00	15.00	0.30	23.50	9.00	5.00	4.61	20.41	0.10	338.97
H20-0006	Ca-HCO3	30.5613463	-22.8609557	8.30	41.50	353.00	40.00	24.00	14.00	0.40	21.20	9.00	8.00	1.44	6.37	0.10	251.18
H20-0007	Ca-NO3	30.5886268	-22.8568960	7.98	33.00	203.38	23.25	12.42	12.48	2.58	7.06	29.57	4.00	14.76	65.34	0.15	55.47
H20-0009	Ca-HCO3	30.5535955	-22.8561760	7.60	45.80	362.00	43.00	24.00	14.00	0.30	29.40	9.00	4.00	3.35	14.83	0.10	253.61
H20-0010	Mg-HCO3	30.5764059	-22.8232884	7.78	17.70	135.36	9.64	8.79	9.80	0.38	12.26	10.00	6.61	2.36	10.45	0.12	84.50
H20-0015	Mg-HCO3	30.5505445	-22.8313478	7.29	25.40	197.91	14.87	11.53	16.86	0.77	17.05	16.06	8.51	0.41	1.81	0.12	127.22
H20-0016	Mg-HCO3	30.5710701	-22.8346764	8.40	38.30	382.00	41.00	28.00	15.00	0.30	26.10	9.00	4.00	2.28	10.09	0.12	274.34
H20-0019	Na-HCO3	30.5109589	-22.9118621	8.80	22.50	153.00	8.00	3.00	32.00	0.40	21.40	15.00	9.00	0.04	0.18	1.00	84.13
H20-0020	Ca-HCO3	30.6179882	-22.8509810	7.47	46.00	363.37	42.00	21.87	19.88	0.30	18.47	23.78	10.32	0.50	2.21	0.15	242.73
H20-0021	Ca-HCO3	30.6163776	-22.8522264	7.90	18.20	127.00	17.00	5.00	8.00	0.40	2.90	13.00	6.00	0.04	0.18	0.10	78.04
H20-0022	Ca-HCO3	30.5121231	-22.9095322	8.00	33.70	265.00	32.00	13.00	18.00	0.30	20.30	7.00	4.00	0.42	1.86	0.30	188.99
H20-0023	Ca-HCO3	30.5292952	-22.9033427	8.30	34.20	267.00	32.00	14.00	14.00	0.30	21.50	10.00	4.00	3.60	15.94	0.10	175.58
H20-0027	Ca-HCO3	30.5316739	-22.8996730	8.12	26.80	200.83	20.35	10.80	13.21	0.48	25.73	13.86	4.00	3.69	16.33	0.16	123.44
H20-0032	Na-HCO3	30.5166766	-22.9049525	8.20	47.30	345.00	24.00	11.00	60.00	0.90	25.10	33.00	11.00	0.04	0.18	1.59	204.84
H20-0036	Mg-NO3	30.3823131	-23.1477666	7.38	30.70	171.85	10.43	11.31	17.25	1.03	9.12	24.01	8.85	18.88	83.58	0.10	15.23
H20-0037	Ca-HCO3	30.3969300	-23.1680700	8.00	79.30	563.31	71.00	28.22	40.29	2.08	36.08	80.82	5.40	15.91	0.00	1.09	263.84
H20-0040	Mg-HCO3	30.5161197	-23.1782931	7.63	108.10	747.25	33.61	83.99	45.50	9.06	39.68	77.14	12.35	3.91	17.31	0.23	467.82
H20-0041	Ca-HCO3	30.4677881	-23.1590981	7.78	58.40	388.77	59.13	17.13	20.05	2.46	37.65	29.84	9.80	3.88	17.18	0.46	232.41
H20-0044	Ca-HCO3	30.4056600	-23.1424500	8.11	54.90	434.74	64.38	15.98	22.65	2.31	39.53	23.25	2.00	0.87	0.00	0.76	299.48
H20-0050	Ca-HCO3	30.5256957	-22.9039327	7.80	34.20	248.02	29.95	16.86	9.65	0.30	15.00	12.28	6.08	3.91	17.31	0.11	155.46
H20-0051	Ca-HCO3	30.6291785	-22.8562362	8.28	53.20	413.71	55.56	26.88	12.89	0.37	31.00	25.60	6.48	8.00	35.41	0.12	250.58
H20-0052	Mg-HCO3	30.6989075	-22.8136495	7.19	17.80	129.87	10.29	7.65	11.35	0.52	26.51	10.31	4.00	1.49	6.60	0.15	80.74
H20-0053	Mg-HCO3	30.7011298	-22.8105117	7.73	25.10	197.73	21.19	13.07	9.95	0.56	28.43	10.25	7.12	0.83	3.67	0.16	131.57
H20-0054	Mg-HCO3	30.7016853	-22.8130115	6.80	12.06	76.24	6.70	4.87	8.39	0.32	11.12	14.07	4.00	0.26	1.15	0.04	38.51
H20-0055	Mg-HCO3	30.7227727	-22.8105144	7.44	18.50	136.96	12.51	8.18	11.48	0.31	19.20	10.00	10.08	0.48	2.12	0.12	86.97
H20-0057	Na-HCO3	30.7227971	-22.8124560	8.06	31.70	257.85	20.63	13.37	27.58	0.41	28.30	10.00	10.79	0.28	1.24	0.13	178.54
H20-0058	Mg-HCO3	30.7144515	-22.7986403	7.25	18.60	134.55	12.61	8.52	10.12	0.55	15.88	10.83	4.00	0.26	1.15	0.14	88.51
H20-0059	Ca-HCO3	30.7252418	-22.7964305	8.52	50.60	400.56	39.95	16.42	40.13	1.16	12.92	32.21	6.00	0.11	0.49	0.23	267.18
H20-0073	Ca-HCO3	30.5370800	-22.8758697	7.85	38.40	308.07	40.05	17.25	12.06	0.34	22.18	11.58	4.91	3.96	17.53	0.15	204.05
H20-0089	Ca-HCO3	30.6144200	-22.8123997	6.69	13.30	98.65	9.82	5.77	6.83	0.30	13.11	10.00	8.03	0.73	3.23	0.11	59.45
H20-0097	Ca-HCO3	30.6538800	-22.8680560	8.32	59.30	460.40	56.54	31.52	17.76	0.15	23.14	25.93	2.00	7.61	0.00	0.19	292.51
H20-0104	Ca-HCO3	30.5240550	-22.9093323	7.43	48.70	328.54	38.64	23.09	19.87	0.30	20.65	41.05	8.37	2.57	11.39	0.20	185.83
H20-0125	Ca-HCO3	30.6891300	-22.8671500	7.97	68.20	579.13	96.28	27.14	12.17	0.15	11.38	33.98	2.00	16.55	0.00	0.30	333.60
H20-0131	Ca-HCO3	30.6631700	-22.8939700	8.17	57.90	496.86	63.66	35.01	18.41	0.15	24.93	24.73	2.00	6.47	0.00	0.19	324.00
H20-0132	Mg-HCO3	30.6652500	-22.9030500	8.20	73.10	560.26	67.46	43.28	18.38	0.15	31.70	37.42	9.80	10.27	0.00	0.16	338.06
H20-0135	Ca-HCO3	30.6402100	-22.9116600	8.17	62.40	499.33	61.75	32.19	17.54	0.15	25.45	25.40	8.98	0.34	0.00	0.15	351.61
H20-0136	Mg-HCO3	30.6337600	-22.9031800	8.25	56.30	431.71	50.94	34.07	18.35	0.15	30.56	36.16	2.00	1.94	0.00	0.18	281.18
H20-0137	Ca-HCO3	30.6402100	-22.9116600	7.11	54.60	406.14	49.75	27.51	14.25	0.15	31.86	27.16	7.83	8.20	0.00	0.16	242.91
H20-0138	Ca-HCO3	30.6227400	-22.9153800	7.89	57.70	451.09	53.72	27.89	17.41	0.15	25.16	18.03	6.26	4.38	0.00	0.21	307.77
H20-0139	Ca-HCO3	30.6150900	-22.9162900	8.07	53.60	415.06	50.83	29.47	17.94	0.15	24.50	24.67	2.00	5.24	0.00	0.36	266.35
H20-0140	Ca-HCO3	30.6150900	-22.9162900	7.58	65.50	506.54	61.47	35.31	17.36	0.15	18.84	34.49	2.00	4.86	0.00	0.17	333.82
H20-0144	Na-HCO3	30.6094440	-22.9388890	8.03	57.00	458.00	39.30	22.80	47.30	1.77	23.92	22.10	7.40	0.19	0.00	0.71	315.80

Borehole nr.	Water type	X	Y	pH	EC	TDS	Ca	Mg	Na	K	Si	Cl	SO4	N	NO3	F	HCO3
H20-0148	Na-HCO3	30.6300400	-22.9416600	7.85	36.50	260.86	9.85	7.73	49.55	0.79	8.55	32.23	7.99	0.07	0.00	0.21	151.90
H20-0151	Mg-HCO3	30.6541600	-22.9100400	8.33	79.10	586.29	69.96	45.56	23.99	0.15	30.85	70.80	13.35	13.37	0.00	0.19	302.94
H20-0152	Mg-HCO3	30.6591670	-22.9075000	7.75	75.80	546.61	66.33	42.49	19.38	0.40	27.38	57.12	13.24	11.20	0.00	0.19	297.84
H20-0157	Mg-HCO3	30.5905600	-22.9489900	7.77	77.70	631.88	69.25	45.68	30.12	0.63	25.41	29.29	8.06	6.99	0.00	0.19	417.52
H200162	Mg-HCO3	30.6041900	-22.9681500	8.01	81.90	595.95	56.77	44.58	32.07	0.79	11.87	74.99	16.15	0.07	0.00	0.29	364.91
H20-0167	Na-HCO3	30.5722365	-22.9741112	8.05	68.40	539.17	39.65	18.92	82.85	2.85	30.39	41.30	4.05	1.37	6.06	0.56	342.67
H20-0171	Mg-HCO3	30.5585600	-22.9549600	7.74	64.50	431.10	44.19	28.20	32.98	0.15	31.94	31.36	6.45	0.06	0.00	0.32	287.18
H20-0173	Ca-HCO3	30.5530400	-22.9565300	8.03	66.50	502.87	56.75	32.50	25.90	0.34	30.99	49.36	12.08	9.05	0.00	0.23	285.58
H20-0175	Mg-HCO3	30.5277300	-22.9715100	8.04	68.60	494.41	53.85	34.61	25.31	1.74	33.91	63.39	8.51	13.50	0.00	0.22	246.90
H20-0177	Ca-HCO3	30.5611255	-22.9941064	8.44	45.70	329.01	32.77	17.28	27.93	4.75	7.36	38.94	9.09	0.11	0.48	0.25	196.44
H20-0189	Ca-HCO3	30.5144568	-22.9646673	7.66	53.20	383.60	42.46	23.69	21.74	0.44	36.53	34.94	7.22	3.67	16.25	0.23	236.54
H20-0196	Na-HCO3	30.4621500	-23.1047297	8.06	55.50	435.31	31.95	24.47	47.29	0.35	8.37	38.50	13.92	0.34	1.51	0.24	276.66
H20-0197	Mg-HCO3	30.4488700	-23.0983300	8.41	95.70	769.20	48.95	53.43	80.71	0.94	18.37	57.36	7.45	2.77	0.00	0.19	507.84
H20-0202	Mg-HCO3	30.4238998	-23.0577118	7.37	54.20	377.78	36.73	27.77	18.92	0.83	34.34	30.73	10.20	13.20	58.43	0.19	193.87
H20-0205	Mg-HCO3	30.4127882	-23.0477124	8.07	38.60	311.10	28.56	23.11	16.06	1.80	22.22	18.85	4.07	0.04	0.18	0.40	218.08
H20-0213	Na-HCO3	30.4602886	-23.1457685	7.82	77.90	599.36	44.56	28.73	79.52	3.06	9.38	70.33	7.01	0.13	0.58	0.53	364.12
H20-0216	Ca-HCO3	30.4819600	-23.1813697	7.32	65.10	497.42	82.90	15.13	29.54	0.64	21.19	55.87	6.03	0.05	0.22	0.70	306.17
H20-0219	Na-HCO3	30.5273400	-23.1721700	8.13	183.00	1325.23	91.53	79.91	164.11	9.08	18.05	231.62	13.61	14.34	0.00	0.64	671.22
H20-0221	Na-HCO3	30.5288800	-23.1837700	8.05	208.00	1387.27	118.52	74.60	177.77	3.93	24.93	296.50	30.50	25.83	0.00	0.45	570.63
H20-0229	Ca-HCO3	30.4686225	-23.2102031	7.31	164.00	1011.74	117.86	68.93	110.67	7.16	31.58	216.91	33.60	3.89	17.22	0.53	438.47
H20-0233	Ca-HCO3	30.4566700	-23.2093713	7.96	65.30	457.40	47.59	28.34	33.99	3.37	36.89	43.36	16.84	4.73	20.94	0.65	262.21
H20-0324	Ca-HCO3	30.5747359	-22.8588409	8.20	57.90	488.00	59.00	30.00	17.00	0.50	23.40	15.00	4.00	4.72	20.89	0.15	342.62
H20-0326	Na-HCO3	30.9255780	-22.5921952	6.50	20.20	112.00	8.00	8.00	20.00	1.00	0.00	31.00	5.00	1.00	4.43	0.20	58.53
H20-0337	Ca-HCO3	30.9064975	-22.5966104	8.44	30.40	227.91	33.31	7.16	15.45	1.08	13.29	22.66	7.88	0.81	3.59	0.18	137.37
H20-0419	Ca-HCO3	30.5878330	-22.8587767	7.63	42.10	340.47	52.54	12.39	14.09	0.54	12.49	16.43	4.46	3.67	16.24	0.53	223.12
H20-0421	Mg-HCO3	30.5607000	-22.9575000	7.79	87.20	676.76	59.49	54.09	54.22	0.69	33.06	121.80	15.31	8.56	0.00	0.20	332.99
H20-0426	Mg-HCO3	30.6461110	-22.8722497	7.73	69.40	500.30	57.78	35.75	19.43	0.40	21.83	36.81	4.00	18.02	79.77	0.17	267.94
H20-0431	Na-HCO3	30.5008610	-22.8057767	7.67	15.90	99.07	7.29	4.70	10.37	1.64	15.92	13.21	4.00	2.01	8.89	0.14	50.71
H20-0472	Na-Cl	30.9086364	-22.5952494	7.13	20.70	119.29	6.53	2.88	22.79	0.96	10.49	30.46	6.93	0.27	1.20	0.15	47.25
H20-0481	Na-HCO3	30.8258560	-22.6533007	8.38	92.90	817.64	58.23	38.95	109.07	0.54	32.92	29.78	4.00	0.71	3.14	0.40	575.41
H20-0482	Na-HCO3	30.8109167	-22.6274997	7.08	39.00	255.89	19.70	12.34	36.70	0.81	33.53	56.90	7.64	3.59	15.89	0.25	105.37
H20-0486	Na-Cl	30.9049974	-22.5972492	6.53	14.30	83.19	4.69	3.76	15.35	0.55	8.80	24.00	4.00	0.63	2.79	0.14	29.69
H20-0519	Mg-HCO3	30.4646000	-23.1185100	8.18	81.10	662.90	47.46	59.09	38.42	2.60	27.64	43.26	6.25	3.26	0.00	0.25	451.03
H20-0522	Mg-HCO3	30.4770300	-22.8283697	7.13	17.40	125.13	11.96	8.10	9.01	0.46	7.67	10.00	4.00	0.11	0.49	0.14	87.74
H20-0523	Na-HCO3	30.4432800	-23.0672500	8.33	55.00	416.10	34.21	18.52	44.68	1.37	21.15	23.35	6.47	2.79	0.00	0.40	274.66
H20-0523	Na-HCO3	30.4430119	-23.0680211	7.73	56.30	457.32	37.70	19.38	52.43	1.22	20.80	21.62	10.48	0.85	3.76	0.44	310.25
H20-0524	Mg-HCO3	30.4551322	-23.1107781	8.00	95.60	799.77	58.92	53.66	85.70	0.18	22.01	105.22	10.24	2.58	11.41	0.56	473.17
H20-0529	Ca-HCO3	30.4893173	-22.8277601	7.23	29.50	229.80	25.51	13.22	12.86	0.46	22.05	11.19	7.01	2.71	12.00	0.14	147.12
H20-0533	Ca-HCO3	30.4386209	-22.9105320	7.44	18.90	147.87	17.71	8.06	7.02	0.41	13.40	10.00	4.00	0.68	3.01	0.12	104.32
H20-0538	Ca-HCO3	30.3783795	-23.0706108	6.87	34.30	248.86	26.13	15.11	17.34	0.47	21.54	23.76	9.48	0.58	2.57	0.13	153.77
H20-0542	Ca-HCO3	30.6117936	-22.8449814	8.07	42.50	347.45	35.95	19.81	20.54	0.49	16.87	13.42	5.09	0.06	0.27	0.19	251.74
H20-0549	Mg-HCO3	30.3724393	-23.0769403	7.60	45.40	370.04	31.48	19.94	34.15	1.86	29.90	17.20	6.72	0.49	2.17	0.23	256.03
H20-0550	Ca-HCO3	30.5724071	-22.8959833	7.12	31.70	180.05	24.74	13.49	10.01	0.30	23.83	27.15	6.50	3.99	17.66	0.13	80.00
H20-0553	Mg-HCO3	30.5396524	-22.7975679	7.14	19.30	141.43	12.08	8.95	9.91	0.30	21.26	10.00	6.33	3.44	15.23	0.11	83.55

Borehole nr.	Water type	X	Y	pH	EC	TDS	Ca	Mg	Na	K	Si	Cl	SO4	N	NO3	F	HCO3
H20-0592	Mg-HCO3	30.3838900	-23.1239200	8.20	74.50	610.61	42.99	35.04	63.05	1.83	17.68	33.21	8.00	0.55	0.00	0.72	423.29
H20-0594	Mg-HCO3	30.4410094	-23.1338776	7.57	106.40	866.39	88.58	61.22	57.85	1.06	29.67	76.11	15.86	2.05	9.07	0.73	555.76
H20-0595	Ca-HCO3	30.4488100	-23.2179800	8.19	68.60	537.02	65.29	25.77	34.32	2.94	38.14	42.91	21.02	0.44	0.00	0.76	341.82
H20-0598	Ca-HCO3	30.4329000	-23.2348200	7.99	87.80	614.00	76.43	39.44	31.19	2.27	39.61	76.91	15.47	19.07	0.00	0.39	287.03
H20-0602	Na-HCO3	30.3996455	-23.1184619	7.90	121.80	959.42	71.91	52.46	125.66	1.91	9.70	132.98	25.99	0.24	1.06	0.37	545.27
H20-0605	Na-HCO3	30.4348424	-23.1984009	7.55	99.40	798.73	63.62	26.43	124.85	2.15	25.23	85.66	10.20	0.04	0.18	1.66	484.00
H20-0607	Na-HCO3	30.4365600	-23.0767700	8.38	63.70	506.64	34.15	18.59	74.53	1.85	12.57	31.38	9.63	3.14	0.00	0.28	322.28
H20-0608	Mg-HCO3	30.4492866	-23.0744373	8.25	59.10	450.16	39.82	34.73	25.14	2.91	32.96	35.48	10.47	6.40	28.33	0.26	272.92
H20-0609	Mg-HCO3	30.4100000	-23.0781386	8.03	50.20	406.04	29.87	35.21	22.48	1.67	30.36	27.88	4.00	2.99	13.24	0.29	273.32
H20-0623	Ca-HCO3	30.6674500	-22.8751700	7.80	53.00	394.96	45.95	25.54	15.66	0.15	22.60	24.20	4.05	1.43	0.00	0.18	272.68
H20-0733	Mg-NO3	30.6572950	-22.7377389	7.38	30.70	171.85	10.44	11.32	17.25	1.04	9.13	24.01	8.86	18.89	83.61	0.10	15.24
H20-0734	Mg-HCO3	30.6172104	-22.8510643	8.34	59.00	496.65	44.17	37.84	28.34	0.30	24.43	33.64	27.49	0.04	0.18	0.25	324.48
H20-0735	Mg-HCO3	30.6294604	-22.8554529	8.38	54.00	419.34	49.67	30.31	14.50	0.37	36.38	28.54	6.95	8.42	37.27	0.13	251.42
H20-0736	Mg-HCO3	30.4493988	-23.0738262	8.43	60.10	468.40	35.60	41.79	27.89	3.06	37.58	38.50	9.23	7.43	32.89	0.22	279.07
H20-0737	Ca-HCO3	30.4395093	-23.1954289	8.20	59.10	456.71	62.60	23.59	19.00	4.09	41.88	35.00	6.19	6.85	30.32	0.59	274.99
H20-0738	Mg-HCO3	30.4027304	-23.0888251	7.82	68.50	522.65	46.58	43.24	29.76	1.33	36.22	46.10	7.05	10.20	45.15	0.22	303.08
H20-0739	Mg-HCO3	30.4363983	-23.0761038	8.28	61.90	483.52	39.16	42.12	28.49	1.65	36.92	33.23	5.87	10.89	48.21	0.20	284.44
H20-0743	Ca-HCO3	30.6525500	-22.8837300	7.89	71.80	571.97	67.65	36.70	21.74	0.15	26.02	41.32	19.78	3.76	0.00	0.19	367.66
H20-0745	Mg-HCO3	30.6731800	-22.8957500	7.96	54.10	394.83	45.63	27.92	14.44	0.15	29.60	37.65	6.10	7.85	0.00	0.15	227.89
H20-0749	Mg-HCO3	30.6318880	-22.9485547	8.00	45.40	350.76	29.53	18.74	33.97	1.13	12.64	17.98	10.83	0.19	0.83	0.35	237.36
H20-0753	Mg-HCO3	30.6164600	-22.9650800	8.07	41.20	325.66	24.97	16.77	30.59	0.75	35.96	19.13	8.74	0.17	0.00	0.33	223.54
H20-0777	Ca-HCO3	30.6143900	-22.9079400	8.05	58.00	490.57	55.17	32.50	17.55	0.34	29.16	19.97	2.00	1.06	0.00	0.19	358.06
H20-0791	Mg-HCO3	30.5419100	-22.9604100	8.02	101.80	861.18	83.59	56.57	70.99	0.44	29.45	141.49	12.13	11.07	0.00	0.24	446.69
H20-0792	Na-HCO3	30.7127968	-22.8159280	7.27	25.60	177.46	12.83	9.36	19.24	0.30	29.18	11.53	4.00	1.07	4.74	0.15	117.22
H20-0794	Mg-HCO3	30.5329900	-22.9690100	7.77	79.30	628.93	66.19	46.47	46.09	1.14	30.40	84.67	12.90	0.83	0.00	0.25	367.47
H20-0807	Ca-HCO3	30.3742700	-23.1564900	8.00	58.50	425.41	55.33	18.48	30.02	1.53	34.77	32.14	2.00	5.45	0.00	0.68	260.99
H20-0821	Ca-HCO3	30.5233800	-23.9616500	8.17	44.20	299.27	33.72	18.03	19.95	0.67	35.62	32.58	6.76	2.55	0.00	0.15	176.03
H20-0834	Mg-HCO3	30.4002700	-23.1238100	8.22	73.80	613.41	40.16	38.05	62.27	5.89	20.29	26.40	6.15	1.33	0.00	0.42	428.07
H20-0849	Mg-HCO3	30.4241300	-23.1055300	8.11	50.60	391.97	23.38	33.64	22.59	3.53	25.31	15.69	2.00	3.48	0.00	0.17	275.49
H20-0900	Mg-HCO3	30.5044440	-23.0352780	7.84	88.30	696.61	71.45	45.58	56.41	0.78	39.83	81.31	48.90	18.63	0.00	1.45	308.04
H20-0947	Mg-HCO3	30.5586700	-23.0229100	7.85	65.80	598.56	42.51	41.19	48.72	3.48	26.38	26.25	4.43	0.02	0.00	0.42	431.27
H20-1038	Ca-HCO3	30.4851500	-22.9575600	8.22	26.90	188.32	19.40	11.68	9.97	0.63	7.82	15.32	3.00	0.06	0.00	0.10	127.92
H20-1045	Mg-HCO3	30.4650400	-23.1463700	8.44	94.80	675.16	61.44	39.37	67.92	2.13	29.37	115.66	6.82	20.54	0.00	0.43	290.43
H20-1046	Mg-HCO3	30.4097300	-23.1140000	8.49	87.80	714.37	33.20	58.53	66.73	4.27	32.62	67.45	3.00	10.47	0.00	0.36	434.47
H20-1204	Na-HCO3	30.8725866	-22.4874825	8.29	189.00	1258.91	95.00	56.95	198.97	2.12	18.21	297.00	33.00	2.26	10.00	0.79	565.02
H20-1205	Mg-HCO3	30.5524300	-23.0514900	8.23	123.30	871.78	31.85	71.66	114.83	5.72	36.10	130.94	12.09	1.22	0.00	0.64	498.57
H20-1209	Na-Cl	30.9046365	-22.4785354	7.96	87.60	560.06	23.61	18.08	131.83	3.62	6.35	158.02	12.65	1.66	7.36	1.22	203.21
H20-1227	Mg-HCO3	30.5697000	-22.9700100	8.56	80.90	646.58	57.18	52.72	32.63	1.82	63.93	48.98	9.62	4.56	0.00	0.23	423.17
H20-1228	Mg-HCO3	30.5761100	-22.9966000	8.21	71.70	555.95	52.68	34.79	45.40	1.33	35.16	48.30	13.17	1.06	0.00	0.33	355.22
H20-1229	Mg-HCO3	30.5764400	-22.9975300	7.96	74.50	604.41	62.12	41.69	34.30	0.67	32.01	42.64	13.39	4.12	0.00	0.36	390.94
H20-1242	Ca-HCO3	30.6141200	-22.9385900	7.69	69.80	542.38	56.38	30.53	45.07	0.57	26.46	23.21	6.57	8.70	0.00	0.33	341.03
H20-1247	Mg-HCO3	30.7563200	-22.8182697	8.14	58.90	445.34	49.09	33.27	20.12	0.03	18.16	30.45	6.00	10.75	47.57	0.02	261.54
H20-1253	Mg-HCO3	30.3977554	-22.9981648	7.41	28.60	215.98	21.20	13.24	13.32	1.81	28.81	12.59	6.00	0.80	3.54	0.20	147.13
H20-1254	Ca-HCO3	30.4498968	-22.9928041	7.23	25.00	177.01	17.18	8.63	12.03	0.89	17.08	15.96	7.83	7.26	32.16	0.20	81.30

Borehole nr.	Water type	X	Y	pH	EC	TDS	Ca	Mg	Na	K	Si	Cl	SO4	N	NO3	F	HCO3
H20-1257	Ca-HCO3	30.3601978	-23.0174689	7.66	20.60	157.64	16.95	8.33	9.13	0.48	27.47	10.17	6.00	0.70	3.12	0.20	106.32
H20-1260	Mg-HCO3	30.4226453	-23.0674100	7.68	61.10	391.80	29.83	33.61	24.85	2.09	30.67	47.76	6.40	21.24	94.03	0.23	152.96
H20-1273	Mg-HCO3	30.5687200	-22.9658000	8.47	84.10	777.55	59.53	65.69	37.52	2.29	33.71	36.65	8.00	1.78	0.00	0.28	559.66
H20-1274	Mg-HCO3	30.5695000	-22.9685500	8.52	65.70	512.06	9.71	64.63	35.32	1.94	33.09	42.72	5.44	1.02	0.00	0.24	347.43
H20-1280	Ca-HCO3	30.6299440	-22.9670547	7.86	69.60	555.05	60.98	29.17	46.05	1.15	22.30	39.49	7.77	12.46	55.16	0.42	314.62
H20-1331	Mg-HCO3	30.5827500	-22.9970000	8.13	87.50	668.15	66.28	45.94	48.91	1.32	30.22	62.28	13.93	6.18	0.00	0.38	401.71
H20-1349	Mg-HCO3	30.5814000	-22.9934400	8.06	74.90	565.14	50.78	35.18	52.90	1.72	27.30	63.20	15.53	7.31	0.00	0.34	313.00
H20-1350	Mg-HCO3	30.5799800	-23.0027400	7.72	75.80	590.05	61.96	41.78	39.49	1.46	33.77	44.28	11.02	0.04	0.00	0.30	389.57
H20-1351	Mg-HCO3	30.5803600	-23.0028300	7.76	79.00	618.74	62.15	41.51	40.43	1.53	38.04	54.66	9.46	0.10	0.00	0.31	408.19
H20-1362	Ca-HCO3	30.5416900	-22.9684100	7.62	67.60	491.35	60.86	35.43	25.13	0.76	31.04	51.05	10.01	6.69	0.00	0.25	277.69
H20-1394	Ca-HCO3	30.5158800	-23.0205200	8.62	56.30	440.08	47.62	26.44	32.17	1.09	30.45	44.12	15.96	5.27	0.00	0.31	248.98
H20-1419	Mg-HCO3	30.5745000	-23.0334100	8.09	68.90	556.07	52.71	41.17	37.43	4.85	25.66	39.88	11.58	10.15	0.00	0.27	323.15
H20-1431	Mg-HCO3	30.5765500	-23.0304000	8.19	39.40	318.98	25.86	22.04	24.89	1.67	28.39	24.64	16.32	2.04	0.00	0.41	193.49
J.Sc07	Mg-HCO3	30.1414000	-23.0526400	7.13	10.00	56.00	5.80	3.80	6.20	1.10	5.30	5.50	4.40	0.14	0.60	0.05	32.10
Mernust 001	Mg-NO3	30.2021000	-23.2507600	8.41	135.00	1108.00	100.00	77.00	49.20	1.90	22.20	157.80	62.60	68.70	304.10	0.05	140.70

APPENDIX B

ISOTOPE ANALYSIS

Field-name:	Description	WMA	TU	±	d ¹⁸ O	dD
H04-0113A	2007/05/30 Marowe	WMA1	0.7	0.2		
H04-0665	2007/05/30 Ngwanalalen	WMA1	0.4	0.3		
H04-0910	2007/05/28 Chloe 2	WMA1	0.7	0.3		
H04-1472	2007/05/16 Vianen	WMA1	0.0	0.2	-4.63	-30
H04-1473	2007/05/16 Harriet's wish	WMA1	0.8	0.2	-3.62	-25
H04-1473	Harriets	WMA1	0.7	0.2	-3.37	-21.7
H04-1473	Harriets	WMA1	0.6	0.2	-3.33	-21.5
H04-1489	2007/05/16 Vianen	WMA1	1.5	0.2	-2.93	-17
H04-1489	Ga-Rawesi	WMA1	1.2	0.2	-2.83	-19.4
H04-1489	Ga-Rawesi	WMA1	1.1	0.2	-2.85	-19.4
H04-1566	2007/05/28 Diana	WMA1	0.0	0.2		
H04-VIANEN	Vianen	WMA1	1.6	0.3	-2.99	-19.5
H10-0165	Mumaila	WMA1	0.8	0.2	-4.38	-25.9
H10-0661	Olifantshoek	WMA1	1.8	0.3	-4.18	-25.2
H11-0818	2007/05/29 Poopedi-Koekoek	WMA1	2.2	0.3		
H11-0833	2007/05/29 Schoonveld 2	WMA1	0.0	0.2		
H11-0885	2007/05/29 Witten	WMA1	0.4	0.3		
H11-1882	2007/05/29 Prespan	WMA1	0.1	0.2		
H11-2212	2007/05/29 Ga-Gare	WMA1	0.3	0.2		
Handpump 001	2007/05/17 Welgelegen	WMA1	0.2	0.2	-4.34	-26
Handpump P008	2007/05/17 Tibane	WMA1	0.1	0.2	-3.25	-25
H-Pump 005	2007/05/16 Aurora	WMA1	0.7	0.2	-4.64	-27
H-Unknown P001	2007/05/16 Harriet's Wish	WMA1	1.0	0.2	-3.17	-20
Jupiter private 001	2007/05/28 Jupiter	WMA1	1.2	0.2		
Chauke unknown 001	2007/05/10 Nwamatatani	WMA2	1.8	0.3	-3.20	-32
H04-0210	Valdezia	WMA2	0.6	0.2	-4.56	-24.4
H04-0211	Valdezia	WMA2	0.8	0.2	-4.55	-24.5
H04-0212	Valdezia	WMA2	1.3	0.3	-3.07	-17.1
H04-0212	Valdezia	WMA2	1.2	0.2	-3.07	-17.1
H10-0015	2007/05/08 Olifantshoek	WMA2	0.4	0.2	-4.51	-24
H10-0019	2007/05/08 Olifantshoek	WMA2	1.1	0.2	-4.48	-26
H10-0028	2007/05/08 Raphalele	WMA2	1.4	0.3	-4.94	-29
H10-0165	2007/05/08 Mamaila	WMA2	1.0	0.2	-6.74	-33
H10-0423	2007/05/08 Itieleng	WMA2	0.2	0.2	-4.74	-27
H10-0437	2007/05/09 Tshebaleng	WMA2	0.4	0.2	-5.19	-29
H10-0461	2007/05/09 Lemondokop	WMA2	0.7	0.2	-4.63	-26
H10-0580	2007/05/09 Lemondokop	WMA2	2.3	0.7	-2.12	-14
H10-0614	2007/05/09 Magoro	WMA2	0.8	0.2	-4.72	-28
H10-0629	2007/05/09 Magoro	WMA2	0.4	0.2	-4.22	-23
H10-0645	2007/05/08 Itieleng	WMA2	0.9	0.2	-5.07	-26
H10-0661	2007/05/09 Olifantshoek	WMA2	0.7	0.2	-4.34	-18
H10-0674	2007/05/09 Tshebaleng	WMA2	0.5	0.2	-5.36	-27
H10-0715	2007/05/08 Phooko	WMA2	2.2	0.3	-5.05	-27
H10-0752	2007/05/08 Itieleng	WMA2	0.8	0.2	-4.68	-27
H17-0098	2007/05/03 Tshivade	WMA2	0.4	0.2	-4.30	-25
H17-0103	2007/05/03 Bungani	WMA2	0.6	0.2	-4.20	-25
H17-0120	2007/05/07 Mashamba	WMA2	0.5	0.2	-4.30	-22
H17-0140	2007/05/02 Valdezia	WMA2	1.9	0.3	-4.35	-23
H17-0179	2007/05/03 Tshivade	WMA2	0.2	0.2		

Field-name:	Description	WMA	TU	±	d ¹⁸ O	dD
H17-0180	2007/05/03 Tshivade	WMA2	0.9	0.2	-4.31	-25
H17-0210	2007/05/02 Valdezia	WMA2	1.4	0.2	-4.55	-31
H17-0211	2007/05/02 Valdezia	WMA2	0.7	0.2	-4.60	-32
H17-0212	2007/05/02 Valdezia	WMA2	0.0	0.2	-3.22	-23
H17-0215	2007/05/02 Valdezia	WMA2	1.3	0.3	-4.49	-23
H17-0420	2007/05/10 Majosi	WMA2	2.0	0.3		
H17-0612	2007/05/09 Sereni	WMA2	1.4	0.2	-3.96	-22
H17-0654	2007/05/03 Bungani	WMA2	1.3	0.2		
H17-0925	2007/05/10 Masia	WMA2	0.5	0.2		
H17-School001	2007/05/11 Mojosi	WMA2	0.6	0.2	-4.75	-28
H17-School002	2007/05/11 Nwamatatani	WMA2	2.0	0.3	-3.07	-18
H17-unknown	2007/05/09 Sereni	WMA2	0.0	0.2	-4.65	-26
J.Sc07	2007/05/02 Schoonuitzicht	WMA2	0.8	0.2	-3.94	-17
Mernust 001	2007/05/09 Mafeba	WMA2	0.9	0.2	-4.55	-27

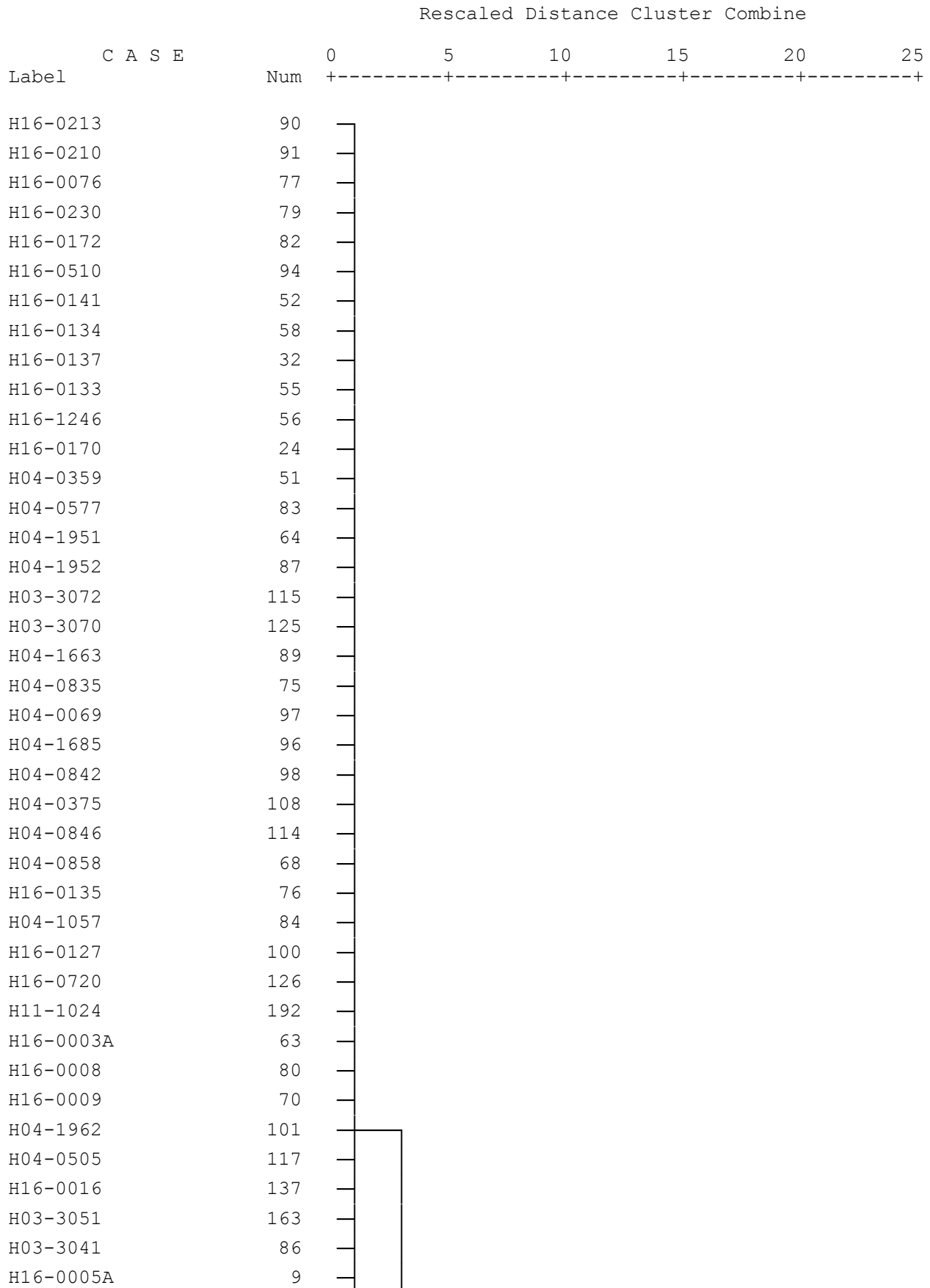
APPENDIX C

CLUSTER ANALYSIS

HOUTRIVER GNEISS CLUSTER ANALYSIS

* * * * * H I E R A R C H I C A L C L U S T E R A N A L Y S I S * * * * *

Dendrogram using Ward Method

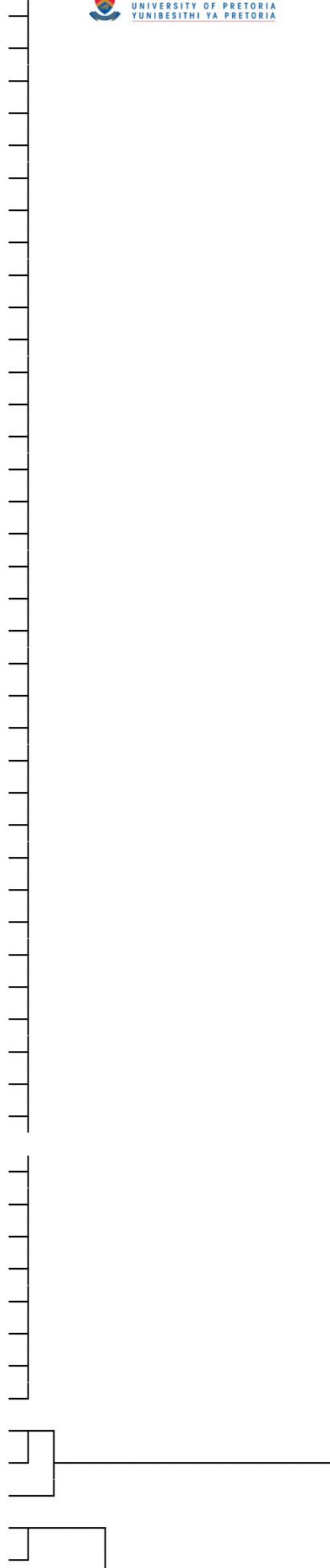


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H04-1049	1	
H04-1643	3	
H04-0402	53	
H16-0014	78	
H04-0969	43	
H04-0061	30	
H04-0978	65	
H04-1486	31	
H04-0125	23	
H04-0964	29	
H04-1566	26	
H04-0679	66	
H04-0989	69	
H04-1604	49	
H04-0092	33	
H04-1644	8	
H04-0859	17	
H04-0233	14	
H04-0841	61	
H04-0072	74	
H04-2178	25	
H04-2177	39	
H16-0397	60	
H16-0192	21	
H16-0022	57	
H16-0002	72	
H03-3055	38	
H16-0194	42	
H04-1840	73	
H16-0372	81	
H11-0961	18	
H04-0684	46	
H03-2580	71	
H16-0156	2	
H04-0116	5	
H16-0150	20	
H04-1689	22	
H04-1545	48	
H04-1675	34	
H04-1825	62	
H04-1633	40	
H04-0113A	47	

H04-1670	50
H16-0921	36
H04-1651	45
H16-0193	19
H16-0136	41
H03-1532	181
H04-0882	222
H04-0078	54
H04-0066	67
H04-1003	92
H11-2096	106
H04-1672	35
H16-0154	37
H04-1666	28
H04-0646	44
H04-1302	88
Jupiter priv	7
H11-1652	183
H11-1823	201
H11-1534	211
H11-1781	229
H11-1763	208
H11-1764	215
H11-1653	188
H11-1654	191
H11-1648	184
H11-2109	205
H11-1498	176
H16-0220	158
H04-1472	169
H16-0749	93
Handpump P00	118
H04-0561	133
H04-0910	170
H04-1392	154
H04-0084	132
H04-0313	144
H11-0833	111
H11-0823	130
H04-0239	143
H11-0698	160
H04-1392	95
H16-0001	146
H11-0737	175
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H16-0025	235
H16-0379	225
H16-0078	234

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H11-1465	245
H11-0833	207
H11-1766	210
H11-0797	196
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H11-0821	180
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H11-0813	182
H16-0164	199
H16-0152	228
H11-1803	217
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H04-2149	200
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H03-3053	265
H04-0105A	216
H16-0160	233
H04-2118	252
H04-0949	242
H11-0885	138
H11-1411	152
H11-1658	178
H11-0002	187
H04-1649	197
H11-0885	236
H04-0243	124
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H04-2146	150
H04-0120	185
H04-0089	186
H04-0773	134
H04-0141	142
H04-0507	136
H04-0099	153
H11-1659	155
H04-1650	139
H04-2201	141
H04-0234	168
H04-1955	172

H04-0792	190
H11-1661	193
H04-0236	195
H03-3042	226
H16-0216	244
H03-3045	213
H16-0315	147
H04-0682	164
H04-0930	145
H11-1487	157
H16-0162	166
H04-1623	162
H04-0645	194
H04-0021	221
H16-0316	254
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H04-2228	123
H04-0456	122
H04-1658	127
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H04-0975	113
H04-2152	109
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H04-1504	59
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H04-1121	110
H04-0183	104
H04-0129	112
H04-0822	128
H04-0241	140
H04-0593	156
H04-0924	116
H16-0153	119
H11-0818	179
H04-0660	206
H04-1970	204
H11-0827	135
H04-1518	151
H16-0309	167
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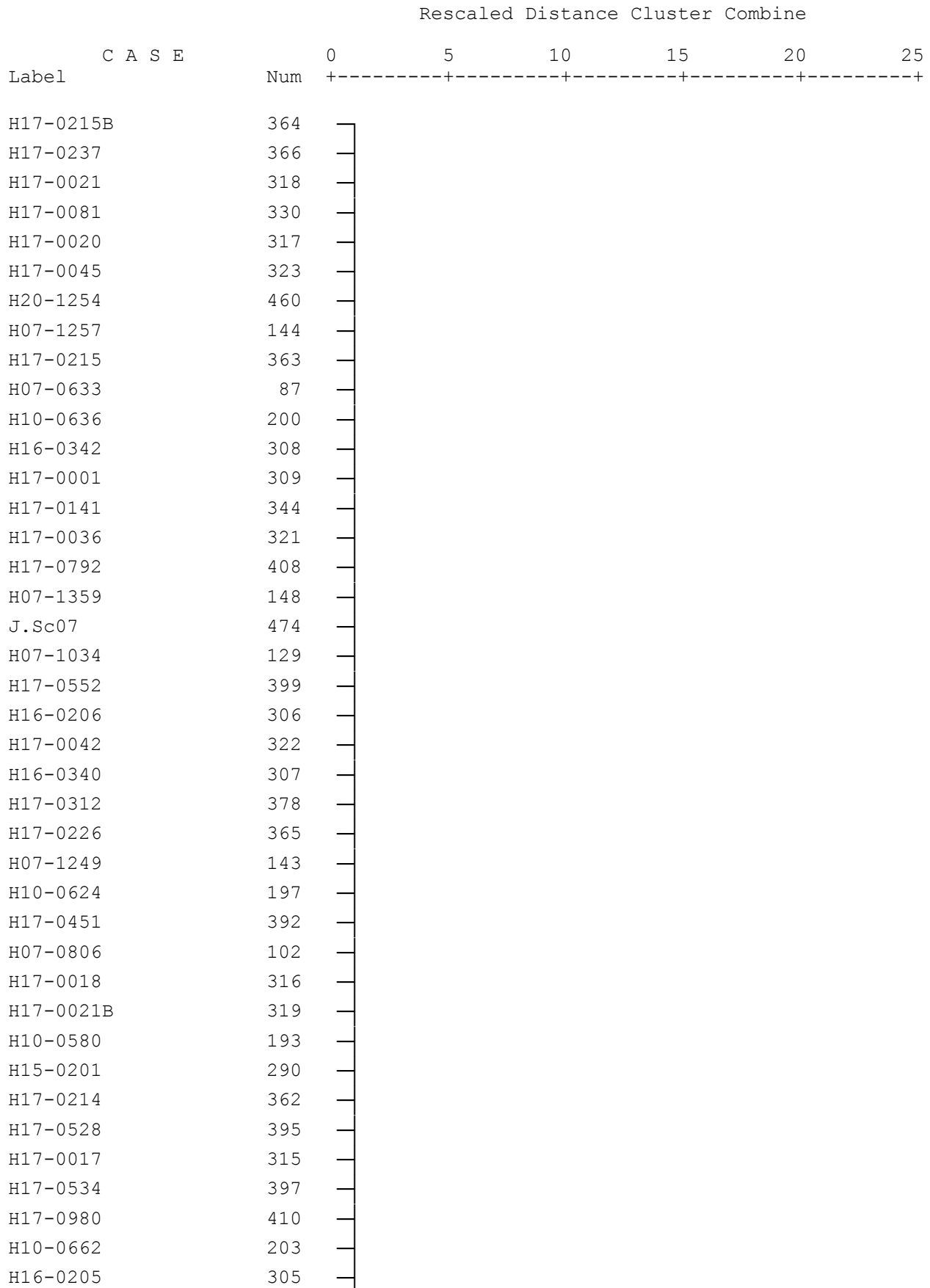


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H11-0923	266		
H11-0948	264		
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H11-0606	255		
H11-1846	257		
H11-1530	250		
H11-1095	256		
H11-0966	260		
H11-0933	243		
H11-2272	248		
H11-0967	251		
H04-0270	259		

GOUDPLAATS GNEISS CLUSTER ANALYSIS

* * * * * H I E R A R C H I C A L C L U S T E R A N A L Y S I S * * * * *

Dendrogram using Ward Method



H14-0340	255
H17-0013	313
H17-0009	311
H20-0609	442
H07-0400	51
H14-0272	250
H17-0010	312
H17-0051	324
H20-0549	437
H17-0982	412
H20-0523	433
H07-0977A	122
H07-1105	133
H20-0753	446
H15-0335	297
H07-0401	52
H10-0604	194
H20-0749	445
H20-0189	425
H20-0202	427
H07-0003	2
H20-0175	423
H20-0807	448
H07-1389	150
H20-1394	471
H17-0062	327
H17-0155	347
H17-0366	383
H17-0408	386
H17-0550	398
H17-0529	396
H17-0080	329
H17-0153	346
H17-0053	325
H17-0156	348
H17-0395	385
H20-1431	473
H17-0015	314
H17-0072	328
H10-0617	196
H20-1253	459
H07-0380	49
H17-0981	411
H20-0538	436
H17-0970	409
H07-1020	128
H07-1074	131
H17-0287	372
H20-0148	418

H17-0103	336
H20-0849	450
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H170159	349
H17-0179	356
H20-1260	462
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H17-0516	394
H17-0092	334
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H17-0420	390
H07-0799	101
H15-0003	282
H10-0614	195



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H17-0393	384
H17-0775	405
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H20-1349	467
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H14-0052	222
H14-0127	237
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H14-0803	267
H14-1027	273
H14-1029	274
H07-0873	112
H07-0876	115
H07-0981	123
H14-0606	261
H07-0454	65
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H20-0219	429
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H07-1407	151
H04-0897	1
H07-1303	145
H07-0810	103
H07-0158	26
H14-0237	243
H07-0204	41
H07-0586	83
H07-0102	14
H14-0058	227
H07-0464	71
H07-0983	124
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H07-0079	7
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H07-0159	27
H10-0165	169

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H14-0264	247	—
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H07-0067	6	—
H07-0095	11	—
H07-0313	43	—
H07-0383	50	—
H07-0198	38	—
H07-0845	108	—
H07-0874	113	—
H17-School100	413	—
H07-0455	66	—
H07-0677	91	—
H07-0352	46	—
H14-0004	213	—
H07-0951	120	—
H07-1310	147	—
H07-1304	146	—
H07-0627	86	—
H07-1147	135	—
H07-0460	68	—
H14-0265	248	—
H07-0542	80	—
H07-0545	81	—
H07-1408	152	—
H17-0116	339	—
H20-1046	454	—

H10-0171	172
H15-0220	295
H07-0203	40
H14-0067	228
H07-0446	63
H14-0128	238
H15-0198	288
H07-0748	100
H07-1368	149
H07-0185A	35
H07-0187	37
H07-0083	9
H07-0200	39
H07-0831	105
H07-0831A	106
H14-0006	215
H15-0097	287
H20-0602	440
H07-0149	24
H07-1179	137
H14-1035	278
H14-1041	280
H07-0522	76
H07-0875	114
H07-0841	107
H07-0865	111
H14-0075	231
H14-0415	259
H07-0467	72
H14-0280	251
H07-0148	23
H07-0414	57
H14-0717	264
H07-0877	116
H07-0944	119
H07-0890	117
H07-0676	90
H07-1238	142
H07-0415	58
H14-0342	256
H14-0626	263
H17-0205	361

