APPENDIX A

Cryogenic Processes and Landforms Spatial Database for Southern Africa

INSTALLATION

1. Insert CD in CD drive.
2. Go to Windows Explorer. Choose the CD-drive that will typically display **000808-1448 (D)**.
3. To install ArcExplorer, click on **Aeclient.exe**. If ArcExplorer is already installed, this action is not necessary. Projects may also be viewed in ArcView.
4. In Windows Explorer, on the CD-directory, there is a INFO.txt file with information regarding the compilation and contents of the CD.

APPENDIX B

Database Components

Appendix B: Database Components

Categories	Subcategories	Database column abbreviation	Full name	Explanation
1. ID		ID	ID	Automatic identification number of entry
2. Information source		Researcher	Author	Author(s) of publication
		Year	Year	Year of publication of paper
3. Identification of the phenomenon		Phenomenon	Phenomenon	Phenomenon identified in the paper according to Appendix C
		Cause1	Cause 1	First cause of phenomenon according to Appendix C
		Cause2	Cause 2	Second cause of phenomenon according to Appendix C
		Cause3	Cause 3	Third cause of phenomenon according to Appendix C
		Cause4	Cause 4	Fourth cause of phenomenon according Appendix C
		Respheno	Author's phenomenon	Terminology used by author(s) to describe phenomenon
		Rescause1	Author's cause 1	Terminology used by author(s) to describe cause 1
		Rescause2	Author's cause 2	Terminology used by author(s) to describe cause 2
		Rescause3	Author's cause 3	Terminology used by author(s) to describe cause 3
		Rescause4	Author's cause 4	Terminology used by author(s) to describe cause 4
		Rescause5	Author's cause 5	Terminology used by author(s) to describe cause 5
		Rescause6	Author's cause 6	Terminology used by author(s) to describe cause 6
4. Geomorphic characteristics		Geomorphic characteristics	Geomorphic characteristics	Type of geomorphic characteristic which describes formation of phenomenon best, i.e. Glacial, Present-day periglacial or Past periglacial
		Activity	Activity	The activity level of a phenomenon, i.e. Relict, Currently active, Currently inactive, Seasonally active
5. Location	5.1 Latitude and longitude	Latitude (S)	Latitude (S)	Latitudinal location of phenomenon
		Latdeg	Latitude degrees	Latitude of phenomenon: degrees
		Latmin	Latitude minutes	Latitude of phenomenon: minutes
		Latsec	Latitude seconds	Latitude of phenomenon: seconds
		Newlat	New latitude	Latitude calculations used in ArcView®
		Newlat2	New latitude 2	Latitude calculations used in ArcView®
		Longitude (E)	Longitude (E)	Longitudinal location of phenomenon

Categories	Subcategories	Database column abbreviation	Full name	Explanation
5. Location (cont.)	5.1 Latitude and longitude (cont.)	Londeg	Longitude degrees	Longitude of phenomenon: degrees
		Lonmin	Longitude minutes	Longitude of phenomenon: minutes
		Lonsec	Longitude seconds	Longitude of phenomenon: seconds
		Newlon	New longitude	Longitude calculations used in ArcView®
		Newlon2	New longitude 2	Longitude calculations used in ArcView®
		Location	Location	Exact name of place where phenomenon was located
		Location1	Location 1	Name of place where phenomenon was located
		Loccation11	Location 11	Name of place where phenomenon was located (control measure)
		Loccation2	Location 2	Name of place where phenomenon was located
	5.2 Altitude	Altitude	Altitude above sea level	Average altitude at which phenomenon was encountered; altitude = (minimum altitude + maximum altitude)/2
		Altitudemin	Altitude minimum	Minimum altitude of phenomenon
		Altitudemax	Altitude maximum	Maximum altitude of phenomenon
6. Specific characteristics	6.1. Age and count	Age	Age	Average age of phenomenon; average = (minimum age + maximum age)/2
		Agemin	Age minimum	Minimum age of phenomenon
		Agemax	Age maximum	Maximum age of phenomenon
		Estimate	Estimate	Estimated age of phenomenon, i.e. Before the LGM, During the LGM, After the LGM, During the Holocene/Present
		Count	Count	Number of phenomena encountered
	6.2 Vegetation	Vegetated	Vegetated	Phenomenon vegetated
		Vegfringe	Vegetation fringe	The phenomenon display a vegetation fringe
	6.3 Sorting and stratification	Sorting occur	Sorting occur	Sorting occur within/on/under the phenomenon
		Stratification occur	Stratification occur	Stratification occur within/on/under the phenomenon
		Sorting	Sorting	In what way is the phenomenon sorted? Gradual, Horizontal, Vertical, Well sorted, Poorly sorted
		Grading	Grading	To what degree is the phenomenon graded checked against the sorting? Very fine, Fine, Fine to coarse, Medium, Medium to coarse, Coarse, Very coarse, Medium to fine, Coarse to fine, Coarse to medium

Categories	Subcategories	Database column abbreviation	Full name	Explanation
6. Specific characteristics (cont.)	6.4 Soils	Soil	Soils	Some form of soil is present within/on/under the phenomenon. Soils include palaeosols
		Sediment	Sediments	Some form of sediment is present within/on/under the phenomenon.
		S1	Soil or sediment 1	First soil or sediment as listed in Soils
		Sthick1min	Soil or sediment thickness 1 minimum	First soil or sediment thickness minimum
		Sthick1max	Soil or sediment thickness 1 maximum	First soil or sediment thickness maximum
		S1%	Soil or sediment 1 percentage	Percentage of first soil or sediment present
		S2	Soil or sediment 2	Second soil as listed in Soil or Sediment
		Sthick2min	Soil or sediment thickness 2 minimum	Second soil or sediment thickness minimum
		Sthick2max	Soil or sediment thickness 2 maximum	Second soil or sediment thickness maximum
		S2%	Soil or sediment 2 percentage	Percentage of second soil or sediment present
		S3	Soil or sediment 3	Third soil or sediment as listed in Soils or Sediment
		Sthick3min	Soil or sediment thickness 3 minimum	Third soil or sediment thickness minimum
		Sthick3max	Soil or sediment thickness 3 maximum	Third soil or sediment thickness maximum
		S3%	Soil or sediment 3 percentage	Percentage of third soil or sediment present
		Scolour	Soil or sediment colour	Colour of soil or sediment of phenomenon i.e. brown, brown to dark, dark
		Squality	Soil or sediment quality	Quality of soil or sediment of phenomenon i.e. humic, heavy
	6.5 Matrix and clasts	Matrixsupported	Matrix supported	Phenomenon material is matrix supported or there is a form of matrix present
		Clastsupported	Clast supported	Phenomenon material is clast supported or there is a form of clast present
		Matrix	Matrix	Matrix of phenomenon i.e. silt, clay
		Matrix1	Matrix1	First matrix as listed in Matrix
		Matrix1char	Matrix 1 characteristics	Characteristics of first matrix type as listed in Matrix
		Matrixcont1min%	Matrix contents 1 minimum percentage	Minimum percentage matrix content of phenomenon
		Matrixcon1tmax%	Matrix contents 1 maximum percentage	Maximum percentage matrix content of phenomenon
		Matrix1thickness	Matrix 1 thickness	Average thickness of first matrix of phenomenon = (matrixdim1min + matrixdim1max)/2

Categories	Subcategories	Database column abbreviation	Full name	Explanation
6. Specific characteristics (cont.)	6.5 Matrix and clasts (cont.)	Matrixdim1min	Matrix dimensions 1 minimum	Dimensions of first matrix of phenomenon: minimum
		Matrixdim1max	Matrix dimensions 1 maximum	Dimensions of first matrix of phenomenon: maximum
		Matrix2	Matrix 2	Second matrix as listed in Matrix
		Matrix3	Matrix 3	Third matrix as listed in Matrix
		Matrix4	Matrix 4	Fourth matrix as listed in Matrix
		Matrixmat1	Matrix material 1	First matrix supported material as listed in Matrixsuppmat
		Ms/mdim1min	Matrix supported material dimensions 1 minimum	First matrix supported material dimensions (minimum)
		Ms/mdim1max	Matrix supported material dimensions 1 maximum	First matrix supported material dimensions (maximum)
		Matrixs/m1profile1	Matrix supported material 1 profile 1	First profile of first matrix supported material
		Matrixs/m1profile2	Matrix supported material 1 profile 2	Second profile of first matrix supported material
		Matrixs/m1profile3	Matrix supported material 1 profile 3	Third profile of first matrix supported material
		Matrixmat2	Matrix material 2	Second matrix supported material as listed in Matrixsuppmat
		Matrixmat3	Matrix material 3	Third matrix supported material as listed in Matrixsuppmat
	6.6 Gradients	Phen:overgrad	Phenomenon overall gradient	The overall gradient at which phenomenon inclines = ((gradient 1 + 2 + 3) = x/3)
		Gradient1	Gradient 1	First gradient at which phenomenon inclines
		Gradient2	Gradient 2	Second gradient at which phenomenon inclines
		Gradient3	Gradient 3	Third gradient at which phenomenon inclines
		Gradient4	Gradient 4	Fourth gradient at which phenomenon inclines
		Slopeangle1	Slope angle 1	Average angle at which slope inclines (1) = (slopeangle1min + slopeangle1max)/2
		Slopeang1min	Slope angle 1 minimum	Minimum slope angle
		Slopeang1max	Slope angle 1 maximum	Maximum slope angle
		Slopeangle2	Slope angle 2	Average angle at which slope inclines (2) = (slopeangle2min + slopeangle2max)/2
		Slopeang2min	Slope angle 2 minimum	Minimum slope angle
		Slopeang2max	Slope angle 2 maximum	Maximum slope angle

Categories	Subcategories	Database column abbreviation	Full name	Explanation
6. Specific characteristics (cont.)	6.6 Gradients (cont.)	Slopeangle:other	Slope angle: other	Other interpretations of slope angle
		Orientation	Orientation	Average compass orientation of phenomenon = (orientation1 + orientation2 …)/x
		Orientation1	Orientation 1	First orientation of phenomenon
		Orientdeg1	Orientation degrees 1	First orientation of phenomenon in degrees (see Fig. 3.4)
		O1%	Orientation 1 percentage	Percentage of phenomenon orientated in direction
		Orientation2	Orientation 2	Second orientation of phenomenon
		Orientdeg2	Orientation degrees 2	Second orientation of phenomenon in degrees (see Fig. 3.4)
		O2%	Orientation 2 percentage	Percentage of phenomenon orientated in direction
		Orientation3	Orientation 3	Third orientation of phenomenon
		Orientdeg3	Orientation degrees 3	Third orientation of phenomenon in degrees (see Fig. 3.4)
		O%3	Orientation 3 percentage	Percentage of phenomenon orientated in direction
		Aligndescr	Alignment description	Description of type of alignment
		Alignment1	Alignment 1	First alignment (degrees)
		Align1%	Alignment 1 percentage	Percentage of phenomena aligned in first direction
		Alignment2	Alignment 2	Second alignment (degrees)
		Align2%	Alignment 2 percentage	Percentage of phenomena aligned in second direction
		Slope	Slope	General slope face phenomenon is encountered on (i.e. on generally eastern slope (E))
		Slope1	Slope 1	First slope phenomenon is located on
		Slope2	Slope 2	Second slope phenomenon is located on
	6.7 Dimensions	Width:length	Width:length ratio	Average width and length ratio of phenomenon = (W/Lmin + W/Lmax)/2 (i.e. 1:2)
		W/Lmin	Width:length ratio minimum	Minimum width:length ratio of phenomenon (i.e.1:2)
		W/Lmax	Width:length ratio maximum	Maximum width:length ratio of phenomenon (i.e.1:2)
		Width	Width	Average width of phenomenon = (widthmin + widthmax)/2
		Widthmin	Width minimum	Minimum width of phenomenon

Categories	Subcategories	Database column abbreviation	Full name	Explanation
6. Specific characteristics (cont.)	6.7 Dimensions (cont.)	Widthmax	Width maximum	Maximum width of phenomenon
		Length	Length	Average width of phenomenon = (lengthmin + lengthmax)/2
		Lengthmin	Length minimum	Minimum length of phenomenon
		Lengthmax	Length maximum	Maximum length of phenomenon
		Height	Height	Average width of phenomenon = (heightmin + heightmax)/2
		Heightmin	Height minimum	Minimum height of phenomenon
		Heightmax	Height maximum	Maximum height of phenomenon
		Depth/thickness	Depth/thickness	Average width of phenomenon = (depthmin + depthmax)/2
		Depthmin	Depth minimum	Minimum depth of phenomenon
		Depthmax	Depth maximum	Maximum depth of phenomenon
		Diameter	Diameter	Average width of phenomenon = (diammin + diammax)/2
		Diammin	Diameter minimum	Minimum diameter of phenomenon
		Diammax	Diameter maximum	Minimum diameter of phenomenon
	6.8 Phenomenon profile	Profile	Profile	Profile of phenomenon (all inclusive) i.e. rounded, large, arcuate
		Other1	Other 1	First other constituent of phenomenon as listed in Other
		Other1 Dim min	Other 1 dimensions minimum	First other constituent's minimum dimensions
		Other1 Dim max	Other 1 dimensions maximum	First other constituent's maximum dimensions
		Other1: profile	Other 1: profile	First other constituent's profile
		Other2	Other 2	Second other constituent of phenomenon as listed in Other
		Other2 Dim min	Other 2 dimensions minimum	Second other constituent's minimum dimensions
		Other2 Dim max	Other 2 dimensions maximum	Second other constituent's maximum dimensions
		Other2: profile	Other 2: profile	Second other constituent's profile
		Other3	Other 3	Third other constituent of phenomenon as listed in Other
		Other3 Dim min	Other 3 dimensions minimum	Third other constituent's minimum dimensions
		Other3 Dim max	Other 3 dimensions maximum	Third other constituent's maximum dimensions

Categories	Subcategories	Database column abbreviation	Full name	Explanation
6. Specific characteristics (cont.)	6.8 Phenomenon profile (cont.)	Other3: profile	Other 3: profile	Third other constituent's profile
		Other4	Other 4	Fourth other constituent of phenomenon as listed in Other
		Other4 Dim min	Other 4 dimensions minimum	Fourth other constituent's minimum dimensions
		Other4 Dim max	Other 4 dimensions maximum	Fourth other constituent's maximum dimensions
		Other4: profile	Other4: profile	Fourth other constituent's profile
		Other5	Other 5	Fifth other constituent of phenomenon as listed in Other
		Other5 Dim min	Other 5 dimensions minimum	Fifth other constituent's minimum dimensions
		Other5 Dim max	Other 5 dimensions maximum	Fifth other constituent's maximum dimensions
		Other5: profile	Other 5: profile	Fifth other constituent's profile
		Note1	Note1	First other characteristic and interesting fact of phenomenon
		Note2	Note2	Second other characteristic and interesting fact of phenomenon
		Note3	Note3	Third other characteristic and interesting fact of phenomenon
		Note4	Note4	Fourth other characteristic and interesting fact of phenomenon
		Note5	Note5	Fifth other characteristic and interesting fact of phenomenon
		Note6	Note6	Sixth other characteristic and interesting fact of phenomenon
		Note7	Note7	Seventh other characteristic and interesting fact of phenomenon
		Note8	Note8	Eighth other characteristic and interesting fact of phenomenon
		Note9	Note 9	Ninth other characteristic and interesting fact of phenomenon
		Note10	Note 10	Tenth other characteristic and interesting fact of phenomenon
		Note11	Note 11	Eleventh other characteristic and interesting fact of phenomenon
		Note12	Note 12	Twelfth other characteristic and interesting fact of phenomenon

APPENDIX C

The Terminology Glossary

The Terminology Glossary

Note: Definitions were taken from the International Permafrost Association (IPA) definition glossary and supplemented by definitions from (i) Goudie *et al.* (1985), (ii) Press & Siever (1986), (iii) Clark (1998) and (iv) Kearey (1996). South African literature was incorporated in some cases. An asterisk (*) stands for not recommended usage of terminology (according to the IPA and other sources). The list of authors at the end of each definition is only listed if they actually called the process or feature by name.

Abbreviations

A	Activity of phenomenon, i.e. whether it is still active or not
AASL	Altitude above sea level
D	Depth range of a phenomenon
Di	Diameter of phenomenon
H	Height range of a phenomenon
L	Length range of a phenomenon
M	The type of matrix present in a matrix supported phenomenon
Publications	Southern African publications of the phenomenon
SN	Sorted, nonsorted or stratified
SS	Soils and sediments present within, under or in the vicinity of the phenomenon in question
Strat	Stratified
Synonyms	Different terminology by which phenomenon is known
Synopsis	A broad description southern African cryogenic phenomena
V	Vegetated
W	Width range of a phenomenon
#	The writer's own definition extracted from other base definitions.

Aréte

A sharp narrow steep-sided mountain ridge, especially one formed when two cirques have been developed back-to-back and combined to form a ridge (Clark, 1998).

Synonym: under certain circumstances, sharp ridge

Publications: Sparrow (1964, 1967b); Sänger (1988); with non-specific reference Hastenrath (1972)

Synopsis: **A** relict

Avalanche

(-ing)

Originally the term was applied to a large mass of snow mixed with earth, stones and ice loosened from a mountainside and falling swiftly by gravity to the valley below. Now it is usually restricted and applied to a fall of a mass of snow, ice and firn, being qualified if used to cover similar movements of other materials, e.g. rock avalanche (better termed as landslide), sand avalanche (plinth). Avalanches are an obvious and impor-tant mechanism of mass wasting in mountainous parts of the earth; they are also highly significant on sub-aqueous continental margins and deltas as well as in extraterrestrial environments, like on Mars. Avalanches occur when the shear stresses on a potential surface of sliding exceed the shear strength on the same plane. Failure is sometimes associated with increased shear stress in response to slope steepening or loading to reduced shear strength within the material and sometimes a combination of the two (Goudie *et al.*, 1985; Clark, 1998).

Publications: Sparrow (1967a); Grab (1996a)

Synopsis: **A** relict; **AASL** 3200-3300m; **SS** humic

Avalanche deposit#

Debris structures left behind by avalanche activity. See Avalanche (-ing).

Publications: Lewis & Dardis (1985)

Synopsis: **A** relict; **M** sand; **D** 1,5 – 1,8m

Basalt step

Basalt outcrop on the contours of a mountainside that look like a step. Basalt steps are believed to be derived form frost wedging. Basalt steps form where the basalt flows are most resistant to chemical weathering and the soil the thinnest (Harper, 1969).

Publications: Harper (1969)

Synopsis: **A** relict; **AASL** 3230-3325m; **SS** chemically weathered modern soils & subsoils; **H** 1.8-6.1m

Blockfield

A superficial layer of angular shattered rocks on top of a flat-topped mountain or a high plateau, sometimes on lowland, formed by *in situ* shattering by frost of a bedrock surface in either modern or Pleistocene periglacial environments (French, 1976, 1996; Washburn, 1979). They may surround features such as tors and nunataks and other landforms subjected to severe periglacial processes (Goudie *et al.*, 1985; Kearey, 1996; Clark, 1998).

...Blockfield-cont.

Synonyms: stone field , blockmeer*, felsenmeer*, boulder field*, rock-block field*, rock river*, rock stream*

Publications: Linton (1969); Sparrow (1971); Borchert & Sänger (1981); Sänger (1988); Marker (1992); Boelhouwers (1994); Grab (1996b)

Synopsis: **A** relict; **AASL** 1500-3260m; **W** 30m; **L** 25m; **D** 1-7m

Blockstream

Lines of boulders, generally angular, formed by *in situ* shattering by frost of a bedrock surface. They may surround features such as tors and nunataks and other landforms subjected to severe periglacial processes (Goudie *et al.*, 1985).

Publications: Hastenrath & Wilkinson (1973); Hagedorn (1984); Lewis (1996a)

Synopsis: **A** relict; **W** 10-30m; **L** 100m; **H** 4-8m

Boulder

Any large, detached, generally rounded mass of rock, larger than a cobble, especially one transported by ice, river or sea, from its original home, but also in some cases one weathered by frost shattering or exfoliation *in situ*, specifically 200 to 265mm in diameter (Kearey, 1996; Clark, 1998).

Boulder bed#

A layer of boulders, separated from the overlying and underlying layers by a defined boundary.

Publications: Sparrow (1967a); Grab (1996a)

Synopsis: **A** relict; **AASL** 1675-3355m; **L** 100m; **H** 1-5m; **Di** 1m

Channel system

A system of running water, cut into debris or bedrock, that serve to drain excess water away from an area (Clark, 1998).

Publications: Hall (1994)

Synopsis: **A** relict; **AASL** 2100m; **W** 100m; **L** 1km; **H** 10m

Cirque

A hollow, open downstream but bounded upstream by an arcuate, cliffed headwall, with a gently sloping floor or rock basin (Goudie *et al.*, 1985). Cirques resemble steep-walled amphitheatres or horse-shaped basins at the head of a mountain valley (sometimes containing a small lake), resulting from frost and glacial action. At the meeting of two cirques a knife-edge or arête is formed (Press & Siever, 1986; Kearey, 1996; Clark, 1998). The cirque floor is eroded by glacier sliding while the backwall is attacked by basal sapping and subaerial rock weathering. Cirques are common in formerly glaciated uplands. They were originally thought to have been formed during the waxing and waning of sheet glaciations, but few were occupied by active glaciers during ice sheet withdrawal. Instead it seems likely that they represent several stages during the last few million years when marginal glaciation affected mid-latitude uplands. Most mid-latitude cirques show a preferred orientation towards the north-east in the Northern Hemisphere reflecting mainly the effect of shade in protecting the glacier form the sun, but also the effect of wind-drifted snow accumulated by predominantly westerly winds. Preferred orientation is less

...Cirque-cont.

important in polar and tropical mountains. Cirque altitude is an indication of former snow lines and it is common for basin altitudes to increase with distance from the coast. The main controls on their morphology remain unclear, but it seems that they tend to become more enclosed and deeper with time (Goudie *et al.*, 1985).

Synonyms: corrie, cwm, trough's end

Publications: Sparrow (1967a, 1967b); Harper (1969); Borchert & Sänger (1981); Sänger (1988)

Synopsis: **A** relict; **AASL** 1675-3355m; **SS** chemically weathered, gritty modern soils & subsoils; **W** 15,25m

Cirque-like hollow:

Publications: Sparrow (1964); Dyer & Marker (1979)

Synopsis: **A** relict; **AASL** 2607-3204m; **SS** peat; **W** 621-1166.7m; **L** 486-1071.4m; **H** 93-280m; **D** 96-230m

Cirque glacier A short-tongued small glacier which fills a separate, rounded basin glacially eroded on a mountainside (Clark, 1998).

Publications: Borchert & Sänger (1981); Sänger (1988)

Synopsis: **A** relict; **AASL** 1900m

Cirque-like hollow See Cirque

Clast A coarse sediment particle, commonly a rock fragment or mineral grain produced by the disintegration of a larger mass, by volcanic explosion, weathering and/or erosion, usually larger than 4mm in diameter; clast sizes include pebbles, cobbles and boulders (Goudie *et al.*, 1985; Kearey, 1996; Clark, 1998).

Publications: as cryogenic phenomenon, Hanvey & Marker (1992); others mention clasts as part of phenomena.

Synopsis: **A** active; **AASL** 3275m

Compacted soil The pressing together of soil particles (e.g. by torrential rain, or by heavy mechanical equipment) so that the voids between them are reduced, with consequent loss of air, to the detriment of soil fertility (Clark, 1998).

Publications: as part of permafrost layers, Fitzpatrick (1978)

Synopsis: **A** relict; **SS** orthic & humic, yellow, brown, grey & black magwa, clovelly & silt-loam

Contraction The decrease in length of a line during deformation (Kearey, 1996).

Publications: Dyer & Marker (1979)

Synopsis: **A** relict; **AASL** 2870-3070m

Corrie sheet see Glacier

Cryogenic process (action) Thermophysical, physico-chemical and physico-mechanical processes occurring in freezing, frozen and thawing earth materials. Specific processes of cryogenic action include water migration during freezing and thawing of the ground, frost heave, heat and mass (moisture) exchange, regelation and gelifluction (Poppe & Brown, 1976).

Publications: Meiklejohn (1992); Boelhouwers (1994); Hanvey & Marker (1994); Marker (1995b)

Synopsis: **A** relict, active; **AASL** 1850-3250m; **SS** humic, massive & organic peat, silt, gravels, modern soils & palaeosols

Cryoplanation The process through which cryoplanation terraces form. Cryoplanation occurs most frequently in periglacial areas of moderate aridity underlain by permafrost, under conditions of intense frost wedging associated with snow banks (Van Everdingen, 1998).

Cryoplanation terrace A step-like or table-like bench cut in bedrock in cold climate regions. Cryoplanation terraces may occur as both hillside benches or bevelled summit surfaces and often lack structural control. They are thought to form under conditions of intense frost wedging associated with snow banks. Cryoplanation terraces are more frequently reported from periglacial areas of moderate aridity. As these areas are usually underlain by permafrost, cryoplanation terraces are regarded by some as diagnostic landforms of permafrost terrain (Eakin, 1916; Demek, 1969; French, 1976; Reger & Péwé, 1976; Washburn, 1979).

Publications: Hagedorn, 1984

Synopsis: **A** relict; **AASL** 1800-2370m; **W** 0.7-2km; **L** 2km; **H** 2m

Cryoturbation Singular meaning: a collective term used to describe all soil movements due to frost action. Plural meaning: irregular structures formed in earth materials by deep frost penetration and frost action processes, and characterised by folded, broken and dislocated beds and lenses of unconsolidated deposits, included organic horizons and even bedrock. Cryoturbation encompasses frost heave, thaw settlement and all differential movements, including expansion and contraction due to temperature changes and the growth and disappearance of ground ice bodies, whether perennial or seasonal. Low temperatures alone are not enough to produce cryoturbation; the water-ice phase change is necessary. Cryoturbation is an important process in the development of patterned ground (French, 1976, 1996; Washburn, 1979; Kearey, 1996). The process is especially active in the zone above permafrost which is subject to seasonal freezing and thawing- the active layer (Goudie *et al.*, 1985).

Synonyms: singular meaning: spew frost*, congeliturbation*, frost churning*, frost stirring*, geliturbation; plural meaning: cryoturbates

...Cryoturbation-cont.

Publications: Borchert & Sänger (1981); Lewis & Dardis (1985)

Synopsis: **A** relict, active; **AASL** 3200-3377m; **SS** subsoils

Cryoturbation features

Publications: Borchert & Sänger (1981)

Synopsis: **A** active; **AASL** 1900m

Cryoturbation features see Cryoturbation

Cutback[#] A narrow, steep-sided valley or pass cut into the slopes of a mountain. According to Grab (1996a) they are ravines or steep, narrow valley heads. They are commonly found in the High Drakensberg and Lesotho Mountains. Some cutbacks contain deposits and are bounded by high summits. Others display large rock niches or hollows on the south-facing aspects.

Publications: Hall (1994); Grab (1996a)

Synopsis: **A** relict; **AASL** 2968-3377m

Debris An accumulation of rock waste consisting of rocks, sand and/or clay, moved from their place of origin and redeposited (Clark, 1998).

Debris deposit

Publications: Lewis (1996a)

Synoposis: **A** Relict; **AASL**; 1930m; **L** 400m

Debris deposit see Debris

Debris fan An accumulation of rock waste consisting of rocks, sand and/or clay, moved from their place of origin and redeposited (Clark, 1998) in a fan-like shape.

Publications: Lewis & Hanvey (1991)

Synopsis: **A** relict; **AASL** 1407-1648m; **SN** yes; **SS** fine black sand, palaeosols; **M** sand, gravel; **H** 20-22m

Debris flow The downslope flow of debris mixed with a minor yet significant amount of water (Innes, 1984).

Publications: Hanvey *et al.* (1986); Lewis & Hanvey (1988); Hall (1994)

Synopsis: **A** relict; **AASL** 1900m

Debris mantle The accumulation of loose rock debris, consisting of weathered rock and soil, lying on the older solid bedrock (Clark, 1998).

Publications: Boelhouwers (1991b)

Synopsis: **A** active; **AASL** 1800m; **SN** nonsorted; **M** diamicton

Debris ridge

A long, narrow, steep-sided rise in the land consisting of rock waste (rocks, sand and/or clay) (Clark, 1998).

Publications: Lewis & Hanvey (1993); Grab (1996a)

Synopsis: **A** relict; **AASL** 3200-3250m; **SS** humic; **L** 18,4-747,35m

Desiccation

Shrinkage during subaerial drying in fine-grained soil and mud material that form cracks (Kearey, 1996; Van Everdingen, 1998).

Publications: Hanvey & Marker (1992)

Synopsis: **A** relict; **AASL** 2870-3070m; SS peat

Desiccation polygon

Publications: Hanvey & Marker (1992)

Synopsis: **A** active; **AASL** 3275m; **Di** 15cm-1m

Desiccation polygon

see Desiccation

Diamicton

A term used to distinguish unconsolidated rocks (Flint *et al.*, 1960). Distinction can be made through the lithofacies code (Eyles *et al.*, 1983).

Earth hummock

A hummock having a core of silty and clayey mineral soil which may show evidence of cryoturbation. Earth hummocks are a type of nonsorted circle commonly found in the zone of continuous permafrost. They develop in materials of a high silt and clay content and/or of high ice content. Earth hummocks found outside the southern limit of present-day permafrost are believed to have formed during a previous period of cooler climate when the area was underlain by permafrost (Tarnocai & Zoltai, 1978; Washburn, 1979; Goudie *et al.*, 1985). The rounded hummocks form an irregular net-like pattern as the result of frost heaving (Kearey, 1996).

Synonyms: mud hummock, earth mound*, tundra hummock*

Emplacement#

An intrusion of material by slow flow into an envelope of pre-existing material. It is not certain if this pertains to solifluction or gelifluction.

Publications: Marker (1992)

Synopsis: **A** active; **AASL** 2300-2800m

Erosion

The process of weathering away of the land surface by natural agents (running water, ice, wave action etc.) and the transport of the rock debris that results. This process excludes mass movement and is not synonymous with denudation (Press & Siever, 1986; Clark, 1998).

Publications: Harper (1969); Marker & Whittington (1971); Meiklejohn (1992); Hanvey & Marker (1994)

Synopsis: **A** relict; **AASL** 1500-3325m; SS chemically weathered modern soils & subsoils

Erosional hollow[#] A term used in southern African context to describe certain valley-type features found in the upper regions of the High Drakensberg and Lesotho Mountains that resemble shallow cirques (also refer to Marker 1989, 1990c, 1991a; Sparrow, 1971, 1973, 1974).

Synonyms: amphitheatre-shaped hollow, cirque-like hollow, hollow, nivation cirque

Publications: Sparrow (1964; 1971); Harper (1969); Marker & Whittington (1971); Hastenrath (1972); Hastenrath & Wilkinson (1973); Nicol (1973); Dyer & Marker (1979); Borchert & Sänger (1981); Lewis & Hanvey (1988); Marker (1989, 1990c, 1991a); Hanvey & Marker (1994)

Synopsis: **A** relict; **AASL** 1600-3355m; **SS** yellow to dark peats, gravels, clays, topped with unconsolidated & oxidised modern soils; **M** gravels & clasts; **W** 400m-2,5km; **L** 400m-2,25km; **H** 21-293m; **D** 93m-1,207km

Flark A wetland comprising accumulations of semi-decomposed plant matter, particularly mosses (that form acid peat), arising from precipitation rather than groundwater (Kearey, 1996). Also a marsh or an area of muddy ground (Goudie *et al.*, 1985).

Publications: Backéus (1989)

Synopsis: **A** seasonal; **AASL** 3200-3300m; **V** yes; **SS** humified, amorphous peat; **L** 15m; **D** 20-60cm

Fluvial Adjective: of or pertaining to a river. Second meaning: Found or living in a river. It is usual to apply fluvial to the action of the river (flow and erosive activity), and fluviatile to the deposits lay down by the river, or to the flora and fauna of a river (Kearey, 1996; Clark, 1998).

Synonym: fluviatile

Publications: Lewis & Dardis (1985); Lewis & Hanvey (1991); Meiklejohn (1992)

Synopsis: **A** relict; active; **AASL** 1675-3355m

Fluvio-glacial The activity of rivers fed by glacial meltwater. The main characteristics of such streams are the highly variable discharge and the high sediment loads. Discharge varies markedly on a wide variety of time scales. Variations over a matter of seconds or minutes relate to the sudden release or closure of basal water pockets as a result of glacier sliding. Fluctuations over a matter of days reflect prevailing weather patterns, whereas a strong seasonal summer flow reflects the effect of glacier in storing winter precipitation only to release it in the ablation season. The muddy colour of meltwater streams reflects their high suspended sediment loads and measurements as high as 3 800mg^{-1} have been measured. In addition the bed load is high and may amount to 90% of the suspended sediment load. Fluvio-glacial landforms may reflect prodigious feats of erosion and sedimentation. Formerly glaciated areas, particularly in mid-latitudes, contain abundant erosional

...Fluvio-glacial-cont.

evidence in the form of deeply incised meltwater channels and giant potholes, sub-glacial channels, courses such as eskers and kames and extensive areas of pro-glacial outwash and lake deposits (glacio-lacustrine) (Goudie *et al.*, 1985; Kearey, 1996; Clark, 1998).

Synonym: glacialfluvio, glacial-fluvio

Publications: Hall (1994); Grab (1996a); Lewis (1996b)

Synopsis: **A** relict; **AASL** 2000-200m; **SS** sand, clay, palaeosols; **W** 100m; **L** 100m-3km; **H** 1-20m

Fluvio-glacial meltwater:

Publications: Hanvey *et al.* (1986)

Synopsis: **A** relict; **AASL** 2225-2340m; **SS** massive & structured sand, clay & silt; **M** massive

Fluvio-glacial deposit(-ion)

The laying down of stratified drift by meltwater, especially in an outwash apron, a varve or a pro-glacial lake. Stratified drift consists of rounded, washed and sorted sand and gravel, unlike till, which is angular or subangular and not sorted (Clark, 1998).

Publications: Sänger (1988), Hall (1994); Grab (1996a); Lewis (1996b)

Synopsis: **A** relict; **AASL** 2000-3200; **SS** sand, clay, palaeosol; **W** 100m; **L** 100m-3km; **H** 1-20m

Fluvio-glacial meltwater

see Fluvio-glacial

Freeze-thaw

A form of weathering in periglacial areas where the temperature hovers around freezing point, below which frost breaks up the rock and above which the ice melts, so that water flows and carries away the rock fragments (Clark, 1998).

Synonym: gelifraction*

Publications: Harper (1969); Marker & Whittington (1971); Sparrow (1971); Fitzpatrick (1978); Hanvey & Marker (1992)

Synopsis: **A** active; **AASL** 1788-3295m

Freezing (of ground)

The changing of phase from water to ice in soil or rock. The temperature at which ground freezing starts may be lower than 0°C because of freezing-point depression (Van Everdingen, 1998).

Publications: Boelhouwers (1995a); see Frozen ground

Synopsis: **A** active; **AASL** 1407-3355m; **SS** organic peat, light black fine sand, palaeosols & modern soils; **M** gravels

Frost action

The process of alternate freezing and thawing of moisture in soil, rock and other materials, and the resulting effects on materials and on structures placed on, or in, the ground. Frost action in soils describes the detrimental processes of frost heave that occurs in the ground during the freezing period, and thaw weakening (followed by thaw settlement) that occurs as the seasonally frozen ground thaws. Although it normally refers to seasonal freezing and thawing processes and effects, the term "frost action" has also been used to describe the long-term heaving that occurs when soils are subjected continuously to a freezing temperature over a long period of time. Frost action contributes to the mechanical weathering (i.e., disintegration or breakdown) of soil and rock materials, by frost wedging, cryoturbation activity, and to the development of cryotexture and cryogenic fabric in soils (Hennion, 1955; Washburn, 1979; Johnston, 1981). The term "frost action" is sometimes used to include a wider range of frost-related processes, such as frost heaving, frost creep, thermal contraction cracking and frost weathering (Goudie *et al.*, 1985).

Synonyms: gelifraction, also frost wedging, frost riving

Publications: Sparrow (1967a); Harper (1969); Hastenrath (1972); Hastenrath & Wilkinson (1973); Fitzpatrick (1978); Borchert & Sänger (1981); Hanvey *et al.* (1986); Marker (1989); Lewis (1987; 1996b); Lewis & Hanvey (1988); Hanvey & Lewis (1991); Grab (1994)

Synopsis: **A** relict, active; **AASL** 1582-3355m; **SS** humic, massive, organic & homogeneous black, brown & grey silt, loam, clay & sand

Frost climate:

Publications: Borchert & Sänger (1981)

Synopsis: **A** relict; **AASL** 1900m

Frost climate

see Frost action

Frost creep

The net downslope displacement that occurs when a soil, during a freeze-thaw cycle, expands normal to the ground surface/slope and settles in a nearly vertical direction upon thawing (Benedict, 1970; Washburn, 1979). Although frost creep is commonly associated with gelifluction, it is a separate process. Movement associated with frost creep decreases from the surface downwards and depends upon frequency of freeze-thaw cycles, angle of slope, moisture available for heave, and frost susceptibility of soil (Goudie *et al.*, 1985).

Publications: Lewis & Dardis (1985); Dardis & Granger (1986); Hanvey & Marker (1992); Boelhouwers (1991a, 1994, 1995a)

Synopsis: **A** active; **AASL** 1800-3260m; **M** mud

Frost heave

The upward or outward movement of the ground surface (or objects on, or in, the ground)

...Frost heave-cont.

caused by the formation of ice in the soil. Frost action in fine-grained soils increases the volume of the soil by freezing of *in situ* pore water and also by drawing water to the freezing front where ice lenses form (ice segregation). Soils that have undergone substantial heaving may consist of alternate layers of ice-saturated soil and relatively clear ice lenses. The lenses are formed normal to the direction of heat flow and when freezing penetrates from the ground surface (which may be horizontal, sloping or vertical), they form parallel to that surface. Frost heave can occur seasonally or continuously if freezing of the ground proceeds without interruption over a period of years (ground temperatures below 0°C). Differential, or non-uniform, frost heaving is one of the main detrimental aspects of the frost action process and reflects the heterogeneous nature of most soils, or variations in heat removal rate and groundwater supply over short distances. Depending on the degree of restraint, large freezing pressures (up to 1 MPa) can be developed as the ground freezes. These can be transmitted to a foundation, structure or other object placed on the ground surface, or embedded or buried in the ground, as basal (i.e., vertical) forces acting on their underside, or through adfreezing of the soil to the sides of the foundation, structure or object (Penner, 1968, 1976; Washburn, 1979; Linell and Lobacz, 1980; Chamberlain, 1981; Johnston, 1981; Kearey, 1996). Frost heaving is usually associated with the active layer above permafrost or with seasonally frozen ground. Frost heaving processes include the upheaving of bedrock blocks, tilting of stones, formation of needle ice, and the sorting and migration of soil particles (Goudie *et al.*, 1985).

Synonym: frost thrust*

Publications: Hastenrath (1972); Dardis & Granger (1985); Lewis (1987); Hanvey & Marker (1992); Boelhouwers (1995a); Grab (1996b)

Synopsis: **A** active; **AASL** 3200m

Frost shattering

The mechanical disintegration of rock by the pressure of the freezing of water in pores and along grain boundaries. Frost shattering is the process of grain loosening and rock disintegration by the freezing pressure of water in films of varying thickness on the surfaces of individual mineral grains. Freezing of the water drawn between the grains by various particle surface forces exerts sufficient differential pressure to loosen and separate the grains (Van Everdingen, 1998). More commonly, the term applies to the complex of weathering processes, both physical and chemical which operate, either independently or in combination, in cold non-glacial environments. The most important physical weathering process is frost wedging which characteristically produces angular fragments of varying sizes. Porous and well-bedded sedimentary rocks, such as shales, sandstones and limestones are especially susceptible to frost weathering or shattering. Features attributed to frost weathering or shattering include extensive areas of angular bedrock fragments

...Frost shattering-cont.

(block fields and block slopes) and irregular bedrock outcrops (tors; Goudie *et al.*, 1985; Kearey, 1996).

Synonyms: congelifraction, frost splitting, frost weathering

Publications: Harper (1969); Hagedorn (1984); Sänger (1988); Marker (1989); Hanvey & Marker (1992); Lewis & Hanvey (1993)

Synopsis: **A** active; **AASL** 3200m

Frost sorting

The differential movement of soil particles of different size ranges as a result of frost action. Frost sorting often accompanies cryoturbation (Washburn, 1979).

Publications: Boelhouwers (1994)

Synopsis: **A** relict; **AASL** 3140-3260m; **SN** sorting

Frost wedging

Frost wedging is the mechanical disintegration, splitting or break-up of rock by the pressure of the freezing of water in cracks, crevices, pores, joints or bedding planes (Washburn, 1979; Kearey, 1996).

Synonyms: congelifraction, frost bursting, frost prying, frost riving, frost cracking, also frost splitting, gelifraction

Publications: Sparrow (1967a); Harper (1969); Hastenrath & Wilkinson (1973); Borchert & Sänger (1981)

Synopsis: **A** active, relict; **AASL** 1900-2530m; **SS** modern subsoils

Frozen ground

Soil or rock in which part or all of the pore water has turned into ice. Perennially and seasonally frozen ground can vary from being partially to extensively frozen depending on the extent of the phase change. It may be described as hard frozen ground, plastic frozen ground, or dry frozen ground, depending on the pore ice and unfrozen water contents and its compressibility under load. Hard-frozen soils are firmly cemented by ice, are subject to brittle failure, and exhibit practically no consolidation under load. Plastic-frozen soils are cemented by ice but have viscous properties due to their high unfrozen water content and therefore will compress under load. Dry-, or friable-frozen, soils have a very low total water content and are not cemented by ice; their compressibility is the same as for unfrozen soils having the same composition, total water content and density (U.S.S.R., 1969, 1973; Van Everdingen, 1976).

Publications: Harper (1969); Borchert & Sänger (1981); Lewis & Dardis (1985); Dardis & Granger (1986); Lewis (1987); Boelhouwers (1995a)

Synopsis: **A** active; **AASL** 2744-3200m; **SN** sorted; **SS** clay & a palaeosol; **M** mud, diamicton

Frozen ground phenomena

Publications: Borchert & Sänger (1981)

Synopsis: **A** relict; **AASL** 1900m

Frozen ground phenomena see Frozen ground

Geliflual action[1] The fast movement of water saturated debris over a frozen substrate. This process differ from gelifluction in that it consist of more water and moves very quickly (Meiklejohn, 1999 *pers. comm.*)

Publications: Linton (1969)

Synopsis: **A** relict; **AASL** 445-2000; **SS** red, brown & grey modern soils & gravel; **M** brown earth, sand & grits

Geliflual apron:

Publications: Linton (1969)

Synopsis: **A** relict; **AASL** 445-2000; **V** yes; **SS** red, brown & grey modern soils & gravel; **M** brown earth, sand & grits; **D** 1-8m

Geliflual deposit

Publications: Linton (1969)

Synopsis: **A** relict; **AASL** 445; **V** yes; **SS** grey-buff modern soils & gravel; **M** rusty coloured chips; **D** 8m

Geliflual apron see Geliflual action

Geliflual deposit see Geliflual action

Gelifluction The slow downslope flow of unfrozen earth materials on a frozen substrate in periglacial environments. Gelifluction is a type of solifluction implying the presence of either seasonal frost or permafrost (Washburn, 1979). Suitable conditions for gelifluction occurs in areas where downward percolation of water through the soil is limited by the permafrost table, where the melt of segregated ice lenses provides excess water in the soil and areas beneath or below late-lying snowbanks. Rates of movement, (between 0.5 and 10.0cm per year), usually decrease with depth. Frost creep is usually measured as a component of gelifluction. As with solifluction, features related to gelifluction include sheets, stripes and lobes (Goudie *et al.*, 1985; Kearey, 1996; Clark, 1998).

Publications: Linton (1969); Lewis & Dardis (1985); Dardis & Granger (1986); Lewis (1987; 1996b); Hanvey & Marker (1992); Boelhouwers (1994)

Synopsis: **A** relict, active; **AASL** 445-3260m; **SS** palaeosol; **M** mud & chips

Gelisolifluction:

Publications: Hagedorn (1984)

Synopsis: **A** relict; **AASL** 1700-2370

[1] The term and process of ***geliflual action***, is not recognised by the IPA.

Gelifluction apron A fan-like deposit at the base of a slope, produced by gelifluction (compare with *solifluction apron*) (Van Everdingen, 1998).

Gelifluction deposit Deposits left by gelifluction action in the form of aprons, sheets, lobes and/or terraces (Van Everdingen, 1998).

Publications: Lewis & Dardis (1985); Lewis (1987)

Synopsis: **A** relict; **AASL** 445-2000m; **SN** some sorted; **M** chips, mud, sand; **D** 30cm-8m

Gelifluction (head) deposit A gelifluction slope deposit accumulation which form through various periglacial mass movement processes induced by seasonal thawing of the active layer, indicating the (former) presence of permafrost (Embleton & King, 1975).

Synonym: head

Publications: Nicol (1973); Lewis (1996b)

Synopsis: **A** relict; **AASL** 1841-2000m; **V** yes; **SN** stratified; **SS** grits, sand, gravels & a palaeosol; **D** 15m

Gelifluction lobe An isolated, tongue-shaped gelifluction feature, formed by more rapid gelifluction on certain sections of a slope showing variations in gradient (compare with *solifluction lobe*).

Gelifluction sheet A broad deposit of nonsorted, water-saturated, locally derived materials that is moving or has moved downslope. Sorted and/or nonsorted stripes might be associated with gelifluction sheets (compare with *solifluction sheet*).

Synonym: gelifluction mantle

Publications: Boelhouwers (1994)

Synopsis: **A** relict; **AASL** 3140-3260m; **SN** sorted; **W** 10m; **L** <20m; **H** <50m

Gelifluction terrace A low step, or bench, with a straight or lobate front, the latter reflecting local differences in the rate of gelifluction movement. A gelifluction terrace may have bare mineral soil on the upslope part and 'folded-under' organic matter in both the seasonally thawed ground and the frozen ground (compare with *solifluction terrace*).

Synonyms: gelifluction bench, gelifluction step

Gelisolifluction see Gelifluction

Glacial Adjective: a landscape occupied by glaciers. In this usage the term is similar to *glacierised*, an alternative which has not found general favour. The term *glaciated* describes a landscape that has been covered by glaciers, but normally in the past (Kearey, 1996). Noun: those occasions during the

...Glacial-cont.

Ice Ages when ice sheets were expanded and average global climates were colder and drier than during intervening *interglacials*. During many of the 17 or so Pleistocene glacials ice sheets covered Canada, northern USA, northern Europe, Britain north of London and north-western Siberia. The existing ice sheets of Greenland and Antarctica expanded offshore while mountain glaciers throughout the world extended into lower altitudes. Sea ice extended further towards the equator as global ocean temperatures fell. Atmospheric and oceanic circulation was modified. It seems likely that the globe as a whole was drier with sub-tropical deserts extending their equator margins and the equatorial rain forest being restricted to discrete islands by the spread of savannah conditions. Mid-latitude areas in the northern hemisphere saw increased wind action with extensive loess deposits in Europe, China and North America (Goudie *et al.*, 1985).

Publications: Sänger (1988); Hanvey & Lewis (1990); Marker (1991b); Lewis & Hanvey (1993)

Synopsis: **A** relict; **AASL** 1850-2135m; **SS** sand, clay, mud & silt

Glacial phenomena:

Publications: Harper (1969); Borchert & Sänger (1981); Sänger (1988); (Hanvey & Lewis (1990); Marker (1991b); Lewis & Hanvey (1993); Hall (1994); Grab (1996a); Lewis (1996b)

Synopsis: **A** relict; **AASL** 1820-3377m; **V** yes; **SN** stratified; **SS** peat, silt, clay, sand & a palaeosol; **M** sand, gravel & mud

Glaciation:

Publications: Grab (1996a)

Synopsis: **A** relict; **AASL** 3200-3300m

Glacial erosion

Erosion by glacier ice by the process of frost shattering, meltwater flow and plucking to form features such as arêtes, cirques, fjords, hanging valleys, horns, know-and-lochan topography and roches moutonnées (Kearey, 1996).

Publications: Harper (1969); Borchert & Sänger (1981); Lewis & Hanvey (1993); Lewis (1996b)

Synopsis: **A** relict; **AASL** 1820-2350m; **SS** chemically weathered, koalinised & organic modern soils, subsoils & palaeosol; **M** sand, silt & gravel

Glacial pavement

Rock surfaces, especially the floor of the glacier (Van der Merwe & De Villiers, 1978), that has been scratched and polished by the movement of debris-laden ice across it (Lewis, 1996a).

Publications: Sänger (1988)

Synopsis: **A** relict

Glacial phenomena see Glacial

Glacial polish A smooth surface developed on bedrock as the result of glacial abrasion (Press & Siever, 1986).

Publications: Harper (1969); Borchert & Sänger (1981); Sänger (1988)

Synopsis: **A** relict; **AASL** 1900-2350m; **SS** chemically weathered modern top- & subsoil

Glacial striation Scratches etched onto a rock surface by the passage over it of another rock of equal or greater hardness. Striations are characteristic of erosion by glaciers but may also occur beneath snow patches and on coasts affected by sea ice. Glacial striations are generally up to a few millimetres in width and rarely more than a metre in length. Larger striations grade into grooves. Striations are best displayed on rock surfaces which face up-ice, mainly because pressure melting in these locations forces the rock tools against the bedrock (Goudie *et al.*, 1985; Press & Siever, 1986; Kearey, 1996; Lewis, 1996a; Clark, 1998).

Synonyms: striae, striations, glacial scratches

Publications: Borchert & Sänger (1981); Sänger (1988); Lewis (1996b)

Synopsis: **A** relict; **AASL** 1900-2500m

Glacier A mass of ice and superficial snow that persists throughout the year and flows downhill under its own weight. The size range is from 100m to 10 000km (Press & Siever, 1986). Originally the term indicated a river of ice moving down a valley (valley glacier, alpine glacier or mountain glacier; Clark, 1998).

Publications: with specific reference to glacier as a feature, Borchert & Sänger (1981)

Synopsis: **A** relict; **AASL** 1900m; **SS** *in situ* koalinised granit soil; **M** sand

Corrie sheet (cirque glacier):

Publications: Borchert & Sänger (1981)

Synopsis: **A** relict; **AASL** 1900m

Plateau glacier:

Publications: Sänger (1988)

Synopsis: **A** relict

Valley glacier:

Publications: Sänger (1988)

Synopsis: **A** relict

Glaciation see Glacial

Grèzes litées Bedded screes of angular rock fragments or rhythmically stratified slope deposit (Dylik, 1960) associated with cold climates and frost shattering. The inclination of the layers parallels that of the slopes, and, in contrast to ordinary gravitational debris slides, the deposits show a striking predominance of fines in their distal parts. Snow patches may play a role in their formation and down-wash is an important process. The rhythmic nature of the sediments suggests that under cold conditions the following process occurs: first, freezing of rocks on a cliff face causes disintegration, and the coarse debris this released slides downward over frozen subsoil; second, the following phase of thaw causes a mantle of half fluid material rich in fines to spread over the stony layer (Goudie *et al.*, 1985; Kearey, 1996).

Synonym: stratified scree

Publications: Lewis & Dardis (1985); Lewis & Hanvey (1988)

Synopsis: **A** relict; **SN** sorted; **M** mud, sand & silt

Ground freeze See Frozen ground and Freezing (of ground)

Ground ice A general term referring to all types of ice contained in freezing and frozen ground. Ground ice occurs in pores, cavities, voids or other openings in soil or rock and includes massive ice. It generally excludes buried ice, except in Russian usage. Ground ice may be epigenetic/syngenetic, contempo-raneous/relict, aggrading/degrading, perennial/seasonal. It may occur as lenses, wedges, veins, sheets, seams, irregular masses, or as individual crystals or coatings on mineral or organic particles. Perennial ground ice can only occur within permafrost bodies (Mackay, 1972; Pollard & French, 1980; Clark, 1998).

Publications: Hanvey & Marker (1992)

Synopsis: **A** active; **AASL** 3275m

Hanging valley A tributary valley whose floor is discordant with the floor of the main valley high up on the valley wall. Hanging valleys are a hallmark of glacial erosion in mountains (Goudie *et al.*, 1985). The tributary enters a larger glacial valley above its base from which a waterfall may descend, and is commonly found where the main valley has been deepened by a glacier that has since disappeared (Press & Siever, 1986; Kearey, 1996; Lewis, 1996a; Clark, 1998).

Synonym: U-shaped valley

Publications: Lewis (1996b)

Synopsis: **A** relict; **AASL** 2000m

Hogsback A long ridge of rock, dipping steeply on both sides that is the exposure of hard rock strata

...Hogsback-cont.

which has been tilted until the originally horizontal beds are almost vertical and display two steep, equally inclined slopes (Goudie *et al.*, 1985). The strata are subject to slower erosion (Press & Siever,1986). A hogsback differs from a cuesta in that both slopes of the ridge are steep and more nearly equal (Kearey, 1996; Clark, 1998).

Synonym: hogback, hog back, hog's back

Publications: Borchert & Sänger (1981)

Synopsis: **A** relict; **AASL** 1900m

Ice

Normally the solid form of water formed by (a) the freezing of water, (b) the condensation of atmospheric water vapour directly into ice crystals, (c) the sublimation of solid ice crystals directly form water vapour in the air, or (d) the compaction of snow. Ice derived from the freezing of water involves, amongst others, ground ice that forms a significant component of permafrost landscapes and the freezing of water within a snow packs to form ice lenses, or in the case of a glacier, superimposed ice. Repeated freezing and thawing is also an efficient means of weathering and can cause rapid rock breakdown. The compaction of snow to form glacier ice involves a number of metamorphic processes whose overall effect is to increase the crystal size and eliminate air passages. Snow which survived a summer melt season and begun this process of transformation ins known as firn. When consolidation has proceeded sufficiently far to isolate the air into separate bubbles the firn becomes glacier ice (Goudie *et al.*, 1985).

Ice-stripped area:

Publications: Sparrow (1967a)

Synopsis: **A** relict; **AASL** 1675-3355m

Ice-shattered ridge:

Publications: Sparrow (1967a)

Synopsis: **A** relict; **AASL** 1675-3355m

Ice-stripped area see Ice

Ice-shattered ridge see Ice

Ice-wedge

A massive, generally wedge-shaped body with its apex pointing downward, composed of foliated or vertically banded, commonly white, ice. Ice wedge size varies from less than 10cm to more than 3m in width at the top, commonly tapering to a feather edge at a depth of 1m to more than 10m. Some ice wedges may extend downward as much as 25m and may have shapes dissimilar to wedges. Epigenetic ice-wedges are characteristically wedge-shaped, whereas syngenetic ice wedges are generally wedge-shaped but with more

...Ice-wedge-cont.

irregular sides. Ice-wedges are formed in thermal contraction cracks in which hoarfrost forms and into which water from melting snow penetrates in the spring. Repeated annual contraction cracking of the ice in the wedge, followed by freezing of water in the crack, gradually increases the width (and possibly the depth) of the wedge and causes vertical banding of the ice mass. The surface expression of ice wedges is generally a network of polygons. Ice wedges growing as a result of repeated (but not necessarily annual) winter cracking are called active ice wedges, in areas of continuous permafrost when developed in mineral soil. Inactive ice wedges can be stable and remain for many centuries without changing (Dostovalov & Popov, 1966; Lachenbruch, 1966; Mackay & Black, 1973; French, 1976; Washburn, 1979; French *et al.*, 1982; Mackay & Matthews, 1983; Goudie *et al.*, 1985).

Publications: Harper (1969); Lewis (1996a)

Synopsis: **A** active; **AASL** 3050m; **SS** modern soil & subsoil; **W** 5cm-10m; **D** 61cm

Ice-wedge cast

A filling of sediment in the space formerly occupied by an ice wedge. An ice-wedge cast is a wedge of secondary filling. When the permafrost thawed, the ice wedge melted and the enclosing and overlying sediments collapsed into the resulting trough. An ice-wedge cast is one of the few acceptable criteria indicating the earlier presence of permafrost. The term "fossil ice-wedge" is not recommended because ice is no longer present (Washburn, 1979, 1980).

Synonyms: pseudomorph*, fossil ice wedge*

Publications: Lewis & Dardis (1985); Lewis (1996a)

Synopsis: **A** relict; **AASL** 1850m; **SS** fine sediments & a palaeosol; **W** 20-40cm; **D** 1-1,8m

Inversion of the weathering profile

The reversal of the normal or expected order of position (Clark, 1998), in this case of the weathering profile.

Publications: Linton (1969)

Synopsis: **A** relict; **AASL** 1200m; **SS** sand, grits

Kame

An imprecise, unspecific term applied to any ridge or mound of poorly sorted water-laid materials (glacial sands and gravels) associated with former fluvio-glacial activity (Goudie *et al.*, 1985; Clark, 1998).

Kame moraine

An irregular, undulating mound of bedded sands and gravels deposited unevenly along the front of a stationary or decaying ice sheet (Press & Siever, 1986; Kearey, 1996).

Synonyms: esker, kame

Publications: Lewis (1996b)

Synopsis: **A** relict; **AASL** 2km; **W** 100m

Kame terrace

A terrace formed between a hillside and a glacier (in a glacial trough) by fluvio-glacial activity. The landform is commonly associated with the former presence of stagnant ice downwasting in valleys (Goudie *et al.*, 1985; Kearey, 1996; Clark, 1998). These terraces consist of sediments deposited by streams that flow beside and parallel to a glacier, or fluvio-glacial sediments. The deposits display characteristics of fluvial deposition in that the constituent sediments tend to be rounded and are water-laid (Lewis, 1996a).

Publications: Lewis (1996b)

Synopsis: **A** relict; **AASL** 2000m; **SS** sand, gravel & a palaeosol; **L** 3km; **H** 20m

Lacustrine deposit

Of or pertaining to a lake, hence applied, e.g. to deposits laid down in a lake; or to terraces on lake margins left when the area of the lake diminishes (Kearey, 1996; Clark, 1998).

Synonym: lacustral deposits

Publications: Hanvey & Lewis (1990)

Synopsis: **A** relict; **AASL** 1850m; **SN** stratified; **SS** massive, organic & laminated silt, gavel & sandstone; **M** mud & sand; **L** 60m; **H** 16m

Mass movement (displacement)

Hillslope failure or the downhill movement of soil or fractured rock under the force of gravity (Press & Siever, 1986). Failures may be in circular, plane, wedge, toppling or settling modes (Goudie *et al.*, 1985). Flow processes include solifluction, soil creep, debris avalanches, earth flows and mudflows. Slide processes include rock falls, rockslides, planar slumps and rotational slumps. Additional there are frost heave, freeze-thaw and cambering movements (Kearey, 1996).

Synonyms: mass wasting, and under certain circumstances: downslope sludging of individual stones, mass flow, slow mass movement

Publications: Hastenrath (1972); Boelhouwers (1991b; 1994); Marker (1992); Meiklejohn (1992)

Synopsis: **A** active; **AASL** 3200m; **SS** subsoil; **S** yes

Slope weathering:

Publications: Hanvey & Marker (1994)

Synopsis: **AASL** 3000-3250m; **SS** brown to dark gravel, peat, silt & a palaeosol

Moraine

An accumulation of unstratified debris, especially boulders and coarse material, directly carried down and deposited by a glacier or ice sheet. The term applies both to the material (till) and to the feature produced. One group of moraines exists on the surfaces of glaciers and includes lateral moraines which form through the accumulation of the valley-side material on either side of the glaciers and medial moraines which form from the junction of lateral moraines as two glaciers meet. In the ablation areas of glaciers such moraines can form prominent upstanding ridges where the debris has protected the underlying ice from melting. The material in lateral and medial moraines is characteristically angular rockfall debris and undergoes minimum modification during transport. The second group occurs at the edge of existing glaciers or in areas formerly covered by glaciers. These include uniform till sheets, streamlined and transverse features. Active glaciers, which end on land, build up moraines at the ice margin. The size of the moraine depends on the period that the margin lies in the same location and also on the amount of rock debris transported to the edge of the glacier. The debris may be deposited as ground moraine when the ice melts or as a terminal or end moraine. The term applies both to the material and to the feature produced. Moraines are used to delimit the former extent of glaciers and can be dated. Problems have arisen in recent years however because many moraines are found to have been built up by successive glacier advances over long time spans. (Goudie *et al.*, 1985; Press & Siever, 1986; Kearey, 1996; Clark, 1998).

Publications: Sparrow (1967a); Borchert & Sänger (1981); Sänger (1988); Lewis (1996b)

Synopsis: **A** relict; **AASL** 1675-2515m

Moraine sheet:

Publications: Borchert & Sänger (1981)

Synopsis: **A** relict; **AASL** 1900m

Moraine sheet

see Moraine

Needle ice

A small-scale heave phenomenon produced by freezing and associated ice segregation at or just beneath the ground surface. Needle ice forms during nights when there is extensive radiative cooling, causing ice segregation in the surface layer of the soil. The needles can form under stones, soil peds, moss or other surface vegetation and are best developed in alpine areas with maritime temperate climates where wet silty or organic soils are present. They can also form on coarse-grained, porous volcanic ejectamenta (Krumme, 1935; Mackay & Matthews, 1974; Washburn, 1979). The needles, which can range in length from a few millimetres to several centimetres, may lift small pebbles or soil particles. The growth of needle ice is usually associated with diurnal freezing and thawing. It is widespread and particularly common in locations in mid-latitudes where the frequency of

...Needle ice-cont.

freeze-thaw is greatest. Needle ice frequently occurs in oriented stripes, and both wind direction and sun have been suggested as explanations for the pattern; it is not clear whether orientated needle ice patterns are primarily a shadow effect developed by thawing or a freezing effect. Thawing and collapse of needle ice is thought significant for frost sorting, frost creep, the differential downslope movement of fine and coarse material, and the origin of certain micro-patterned ground forms. The importance of needle ice as a disruptive agent has probably been underestimated, especially in exposing soil to wind and water in periglacial regions. In other areas it may be responsible for damage to plant materialswhen freezing causes vertical mechanical stress within the root zone (Goudie *et al.*, 1985).

Synonym: pipkrake

Publications: Hastenrath (1972); Hastenrath & Wilkinson (1973); Lewis (1987); Sänger (1988); Verster & Van Rooyen (1988); Marker (1989); Boelhouwers (1991a); Hanvey & Marker (1992); Grab (1996b)

Synopsis: **A** active; **AASL** 1800-3410m; **H** 5cm

Needle ice activity Patterns formed in the ground by the growth and decline of needle ice.

Synonyms: raked patterns*, raked ground*, striated soil*, needle ice stripes

Publications: Hastenrath & Wilkinson (1973); Lewis (1987); Sänger (1988); Marker (1989); Boelhouwers (1991a); Hanvey & Marker (1992); Grab (1996b)

Synopsis: **A** active; **AASL** 1800-3410m; **H** 5cm

Surface creep

Publications: Sänger (1988)

Synopsis: **A** active

Net A form of patterned ground (see Patterned ground)

Publications: Hastenrath & Wilkinson (1973); Boelhouwers (1991a)

Synopsis: **A** active; **AASL** 1181-3200m; **SN** sorted (see Sorted net); **W** 5-20cm

Niche (hollow) A small recess or shelf in a rock face (Clark, 1998; also refer to Grab, 1996b).

Publications: Marker (1991b); Grab (1996a)

Synopsis: **A** relict; **AASL** 3295-3377m

Niche glacier

A small cirque glacier, lying in a funnel-shaped hollow high in a steep mountain slope (Clark, 1998).

Publications: Hall (1994)

Synopsis: **A** relict

Nivation

A general term for the localised erosion of a hillside by frost action, mass wasting and the sheet flow or rill work of meltwater at the edges of, and beneath, lingering snow patches (however, in contrast to those produced by glacier ice). The theory is that nivation produce nivation hollows and niches, which, as they grow in depth, trap more snow and thereby enhancethe process of deepening. The disintegration of the rock brought about by freeze-thaw and chemical weathering (sometimes termed snow patch erosion), may eventually lead to the formation of a nivation cirque. Topographic and climatic controls strongly influence the distribution and orientation of nivation hollows. The most favoured locations are on hillsides protected from the sun and with an ample supply of drifted snow. In mid-latitudes these factors favour a north-eastern orientation in the Northern Hemisphere and south-eastern orientation in the Southern Hemisphere (Goudie *et al.*, 1985; Kearey, 1996; Clark, 1998).

Publications: Sparrow (1967a); Harper (1969); Nicol (1973); Dyer & Marker (1979); Borchert & Sänger (1981); Lewis & Hanvey (1988); Marker (1986, 1989, 1990b); Hanvey & Lewis (1991); Hall (1994); Lewis (1994, 1996b)

Synopsis: **A** relict; **AASL** 1675-3355m; **SS** sand & modern soil; **M** silt, clay

Nivation niche

A semi-circular steep-sided depression formed by nivation (Harper, 1969).

Publications: Harper (1969); Marker (1989)

Synopsis: **A** relict; **AASL** 1800-2837m; **V** yes

Nonsorted circle

A patterned ground form that is equidimensional in several directions, with a dominantly circular outline that lacks a border of stones. Nonsorted circles characteristically have margins of vegetation; they occur singly or in groups; their diameter is commonly between 0.5 and 3.0m. Their central areas tend to be slightly dome-shaped and may be cracked into small, nonsorted polygons. In places, the long axes of stones and sand particles tend toward vertical. The term covers both mud circles, developed in fine-grained materials, and stony earth circles, developed in gravelly materials (Washburn, 1979).

Synonym: tundra hummock*

Publications: Harper (1969); Hastenrath & Wilkinson (1973); Borchert & Sänger (1981); Boelhouwers (1991a)

Synopsis: **A** active; **AASL** 1181-3354m; **SN** nonsorted; **V** mostly; **SS** gritty modern soils & subsoils; **W** 40cm; **Di** 20-60cm

Nonsorted net A type of patterned ground with cells that are equidimensional in several directions, neither dominantly circular nor polygonal, and lacking borders of stones. Nonsorted nets occur on nearly horizontal surfaces. Diameters of individual cells range from 0.5m to 10m. Where vegetation is sparse, it is generally concentrated in furrows bordering the individual cells of the net, emphasising the pattern (Washburn, 1979).

Nonsorted polygon A nonsorted polygon is a patterned ground form that is equidimensional in several directions, with a dominantly polygonal outline that lacks a border of stones. Nonsorted polygons commonly occur in extensive patterns, most frequently on nearly horizontal surfaces (although small forms have been found on slopes up to 27°; large ones have been found on slopes as steep as 31° in polar regions). Micro-scale polygons range in size from 5cm to 1m; macro-scale polygons may be more than 100m in diameter. Where vegetation is sparse, it is generally concentrated in furrows along the borders between the polygons, emphasising the pattern. The mineral soil can be well-sorted fines, sand, gravel, or a mixture (Washburn, 1979).

Publications: Harper (1969); Hastenrath (1972); Lewis (1987, 1996b); Hanvey & Marker (1992)

Synopsis: **A** active; **AASL** 2900-3354m; **SN** nonsorted; **SS** gritty modern soil; **W** 6-20cm

Nonsorted step A patterned ground feature with a step-like form and a downslope border of vegetation embanking an area of relatively bare ground upslope. Nonsorted steps are only found on slopes commonly ranging from 5° to 15°; their downslope border forms a low riser fronting a tread whose slope is less than the general slope. Nonsorted steps are assumed to be derived from nonsorted nets or hummocks or nonsorted polygons, rather than to develop independently (Washburn, 1979).

Nonsorted stripe A form of patterned ground with a striped and nonsorted appearance, due to parallel strips of vegetation-covered ground and intervening strips of relatively bare ground, oriented down the steepest available slope. Nonsorted stripes, both large and small, occur on slopes of 5° to 6°, downslope from nonsorted polygons or nonsorted nets. In some places the vegetated and non-vegetated strips are equally wide; in other places vegetated strips of 0.3 to 0.6m are spaced from 3 to 4.5m apart. They can be several hundred metres long (Washburn, 1956).

Palaeosol An ancient, fossil or relict soil or soil horizon in the sedimentary rock record, formed on a past landscape, documented for both the Precambrian and Phanerozoic (Goudie *et al.*, 1985; Press & Siever, 1986; Kearey, 1996).

Synonyms: ancient soil, fossil soil, relict soil

Publications: Harper (1969); Lewis & Hanvey (1991, 1993); Hanvey & Marker (1994); Marker (1995b); Lewis (1996a)

Synopsis: **A** relict; **AASL** 1407-3175m; **V** yes; **SS** brown soils; **D** 40cm-2.5m

...Patterned ground-cont.

Patterned ground A general term for any ground surface exhibiting a discernibly ordered, more or less symmetrical, morphological pattern of ground and, where present, vegetation. Some patterned ground features are not confined to permafrost regions but they are best developed in regions of present or past intensive frost action. A descriptive classification of patterned ground includes such features as nonsorted and sorted circles, nets, polygons, steps and stripes, and solifluction features. In permafrost regions, the most ubiquitous macro-form is the ice-wedge polygon, and a common microform is the nonsorted circle. The latter includes mud boils, mud hummocks, frost boils, stony earth circles, earth hummocks, turf hummocks, thufa and tundra hummocks. Nonsorted circles are not all of the same origin. Mud and earth hummocks and frost boils, involve cryoturbation activity and differential heave of frost-susceptible materials. Mud boils involve hydraulic pressures and diapiric displacements of water-saturated sediments. The genesis of many types of patterned ground phenomena is not clearly understood. Patterned ground also occurs in peatland in the form of string fens and other peatland features (Washburn, 1956, 1979; Mackay & MacKay, 1976; Stanek, 1977; Tarnocai & Zoltai, 1978; Shilts, 1978; Mackay, 1980; Stanek & Worley, 1983; Goudie *et al.*, 1985; Kearey, 1996).

Publications: Harper (1969); Hastenrath (1972); Hastenrath & Wilkinson (1973); Borchert & Sänger (1981); Dardis & Granger (1986); Lewis (1987, 1996b); Boelhouwers (1991a, 1994, 1995a); Hanvey & Marker (1992); Grab (1996b)

Synopsis: **A** active & relict; **AASL** 1181-3210m; **SN** sorted & nonsorted; **SS** chemically weathered & gritty modern soils, subsoils, clays, silts, sands & gravels; **W** 6cm-2m; **L** 1cm-10m; **Di** 15cm-6m

Pebble A small stone, naturally rounded by the action of water or wind, diamater between that of gravel and cobble. There is some confusion over precise size, but a pebble is commonly defined as having a diameter between 10 and 50mm (Clark, 1998).

Publications: concerning pebbles modified by glacial action: Sänger (1988)

Synopsis: **A** relict

Periglacial process A process commonly associated with a periglacial environment, e.g. freeze-thaw, solifluction, gelifluction, cryoturbation etc.

Publications: Sparrow (1964); Hastenrath (1972); Borchert & Sänger (1981); Hagedorn (1984), Lewis & Hanvey (1988); Marker (1989); Hanvey & Marker (1992); Lewis (1996a)

Synopsis: **A** active & relict; **AASL** 1700-3200m; **SS** subsoils

Periglacial slope-wash:

Publications: Lewis & Hanvey (1988)

Synopsis: **A** relict; **M** sand & silt

Periglacial slope-wash see Periglacial process

Permafrost Ground (soil or rock and included ice and organic material) that remains at or below 0°C for at least two consecutive years. Permafrost is synonymous with perennially cryotic ground: it is defined on the basis of temperature. It is not necessarily frozen, because the freezing point of the included water may be depressed several degrees below 0°C; moisture in the form of water or ice may or may not be present. Whereas all perennially frozen ground ispermafrost, not all permafrost is perennially frozen. Permafrost should not be regarded as permanent, because natural or man-made changes in the climate or terrain may cause the temperature of the ground to rise above 0°C. Permafrost includes perennial ground ice, but not glacier ice or icings, or bodies of surface water with temperatures perennially below 0°C; it does include man-made perennially frozen ground around or below chilled pipelines, hockey arenas, etc. Russian usage requires the continuous existence of temperatures below 0°C for at least three years, and also the presence of at least some ice (Muller, 1943; Van Everdingen, 1976; Kudryavtsev, 1978). A differentiation is made between cryotic (below 0°C) and non-cryotic (above 0°C) ground. The former is subdivided into unfrozen, partially frozen, and frozen, depending upon the amount of unfrozen water present. The upper boundary of permafrost is known as the permafrost table, and the near-surface layer which is subject to seasonal thaw is called the active layer. The depth at which annual temperature fluctuations are minimised is termed the depth of the zero annual amplitude; this usually varies between 10 to 20m depending on climate and terrain factors such as amplitude of annual surface temperature variation snow cover, and effective thermal diffusivity of the soil and rock (Goudie *et al.*, 1985).

Synonyms: perennially frozen ground, perennially cryotic ground, biennially frozen ground*, climafrost*, cryic layer*, permanently frozen ground*

Publications: as causative, Boelhouwers (1994)

Permafrost process:

Publications: Lewis (1996a)

Synopsis: **A** relict; **AASL** 1930m

Permafrost layer:

Publications: Fitzpatrick (1978); Lewis (1996a)

Synopsis: **A** relict; **AASL** 2500m; **SN** stratified; **SS** humic & orthic yellow, black & brown magwa, clovelly & silt

Permafrost layer see Permafrost

Permafrost process see Permafrost

Pinnacle A rock wall weathered into tower-like features thought to be indicative of strong frost action (see Borchert & Sänger, 1981; Goudie *et al.*, 1985).

Synonym: gendarme

Publications: Borchert & Sänger (1981)

Synopsis: **A** relict; **AASL** 1900m

Plateau glacier see Glacier

Polygon Closed, multi-sided, roughly equidimensional patterned-ground features, bounded by more or less straight sides; some of the sides may be irregular. Macro-scale polygons, typically 15m to 30m across, result from thermal contraction cracking of the ground and form random or oriented polygonal patterns. They occur in both mineral terrain and peatland. Ice-wedge polygons are common in poorly drained areas and may be either high-centred or low-centred. Sand-wedge polygons occur where wedges of primary mineral infill underlie the polygon boundaries. Some polygons may be formed by seasonal frost cracking in areas of deep seasonal frost. Micro-scale polygonal patterns, usually less than 2m in diameter, are normally caused by desiccation cracking (Rapp & Clark, 1971; Washburn, 1979; Clark, 1998).

Synonyms: frost polygon, frost-crack polygon, depressed-centre polygon*, fissure polygon*, raised-centre polygon*, Taimyr polygon*, tundra polygon*

Publications: Harper (1969); Hastenrath (1972); Hastenrath & Wilkinson (1973); Lewis (1987; 1996b); Hanvey & Marker (1992); Boelhouwers (1991a; 1995a)

Synopsis: **A** active & relict; **AASL** 2550-3355m; **SN** sorted & nonsorted; **SS** chemically weathered, gritty modern soils & subsoils; **W** 4-20cm; **Di** 15-60cm

Pothole Applied loosely to any deep hole, vertical cave system or underground cave, in limestone country, hence the term potholing for carving or exploring underground caverns etc. In studies of erosion, a more or less circular hole worn in rocks by whirling stones, as in the bedrock of the channel of an eddying swift stream (Press & Siever, 1986; Clark, 1998).

Publications: Sänger (1988)

Synopsis: **A** relict

Protalus rampart A ridge or ramp of accumulated coarse angular rock debris, resembling a moraine, consisting of material that has slipped down from perennial banks of snow, and lying parallel to the slope that produced it (Shakesby, 1997; Clark, 1998).

Synonym: pronival rampart, snow slope detritus*, snowbank accumulation*, snowbank

...Protalus rampart-cont.

deposit*, winter-talus ridge*, nival moraine*, nivation moraine*, and under certain circumstances, debris lobe

Publications: Nicol (1973); Marker (1989, 1990b); Lewis (1994, 1996b)

Synopsis: **A** relict; **AASL** 1800-2837m; **V** yes; **W** 52-83m; **L** 217m-1.5km; **H** 8.5-104m; **D** 8-16m; **Di** 27-69m

River terrace

A part of former floodplain of a river, left on the side of a river valley as the stream cut down its bed and now appearing as a generally flat, step-like strip on the side of the valley, at a level higher than that of the presentchannel. Such a terrace is usually built up of gravel, coarse sand and alluvium deposited by the river when its was flowing at the level of the terrace. Thus the terrace represents a part of the valley floor at that time, and may not be perfectly flat. The term is applied to a rock bench as well as to a gravel-covered terrace (Clark, 1998).

Publications: Marker (1989); Lewis & Hanvey (1991)

Synopsis: **A** relict; **AASL** 1407-2837m; **SN** nonsorted; **SS** sand, gravel; **D** 15-35m

Rochés moutonnées

Glacially moulded outcrops of rock that are asymmetric in cross-section, with a gently ascending striated and polished up-flow side and a steep and ice-plucked down-flow side (Lewis, 1996a).

Publications: in describing tors in the High Drakensberg and Lesotho Mountains: Grab (1996a)

Synopsis: **A** relict; **AASL** 2968-3377m

Rockglacier

A mass of rock fragments and finer material, on a slope, that contains either interstitial ice or an ice core and shows evidence of past or present movement. Rockglaciers do not form where there is insufficient moisture to form the interstitial ice that permits movement of the mass. There are two main theories of origin: that the rock debris has ice mixed in the spaces between the rock (the interstitial ice model), or that the debris is a thick covering in a thin, probably decaying true glacier (the glacier ice model). One major feature is that rockglaciers usually exhibit slow movement, often less than a metre per year, but it has also been noted that active rockglaciers may move at speeds up to 50m per year and possess steep fronts with slope angles greater than the angle of repose. Rockglaciers are said to be inactive when the main body ceases to move and most rock glaciers have transverse ridges and furrows on their surface (Capps, 1910; White, 1976; Washburn, 1979; Goudie *et al.*, 1985; Press & Siever, 1986).

Publications: Lewis & Hanvey (1993); Lewis (1996a)

Synopsis: **A** relict; **SN** sorted; **SS** organic, containing palaeosols; **M** sand, silts, clays; **W** 30-250m; **L** 200-550m; **H** 4-30m

Scree

First meaning: A slope consisting of an accumulation of loose angular rock debris of any size and commonly formed by frost action from the parent rock, lying at a uniform angle (commonly of 35°) at or near the foot of a steep cliff, rock-buttress, mountain etc. Second meaning: The angular rock debris itself. Third meaning: A synonym for talus, angler of repose, mass movement. repose slope (Clark, 1998). The scree may be metres to hundreds of metres in height (Goudie *et al.*, 1985; Press & Siever, 1986; Kearey, 1996).

Synonym: talus

Publications: Sparrow (1967a); Marker (1986, 1992); Lewis (1994); Sumner & De Villiers (*in prep.*)

Synopsis: **A** relict; **AASL** 1582-3355m; **V** yes; **W** 37-75m; **L** 100-235m; **H** 1-3m

Segregation ice

Ice in discrete layers or ice lenses, formed by ice segregation. Segregated ice can range in thickness from hairline to more than 10m. It commonly occurs in alternating layers of ice and soil (Taber, 1929; Mackay, 1966; Penner, 1972).

Synonyms: segregated ice, ice gneiss*, sirloin ice*, Taber ice*

Publications: Boelhouwers (1994); Grab (1996b)

Synopsis: **A** active; **AASL** 3140-3410m

Sheet-wash

A flow of rainwater that covers the entire ground surface with a thin film and is not concentrated into streams (Press & Siever, 1986). Overland flow on all but the smoothest surfaces and on all natural hillsides, breaks into threads of high velocity separated by areas of slower and shallower flow. Sediment entrainment by the flow occurs only within the more rapid threads. In the sheet-wash areas between, sediment detached or dislodged by rain-splash will be transported farther than in the absence of flow, so that sheet-wash has a small influence on sediment transport even though it cannot initiate erosion (Goudie *et al.*, 1985; Press & Siever, 1986; Kearey, 1996).

Synonym: sheet-flow

Publications: Lewis & Dardis (1985); Watson (1988)

Synopsis: **A** active & relict; **V** yes; **SN** sorting; **SS** acid leached & weathered hutton, griffen & mispah-glenrosa; **M** mud & sand

Slope weathering

see Mass movement (displacement)

Snow patch

A relatively small area of snow cover remaining after the main snowmelt period. Such areas commonly represent remnants of snowdrifts (Van Everdingen, 1998) and initiate processes associated with nivation (Goudie *et al.*, 1985).

Snow patch conditions:

Publications: Sparrow (1967, 1973); Nicol (1973); Dyer & Marker (1979); Marker (1990); Lewis (1994)

Synopsis: **A** relict; **AASL** 1675-3355m; **SS** peat

Snow patch meltwater

Publications: Marker (1989)

Synopsis: **A** relict **AASL** 1800-2837m

Snow patch conditions

see Snow patch

Snow patch meltwater

see Snow patch

Soil creep

The imperceptible downhill flow of soil under the force of gravity. It is a shear flow with velocity decreasing downward and occurs even on gentle slopes (Press & Siever, 1986).

Synonym: soil flow

Publications: Borchert & Sänger (1981); Verster & Van Rooyen (1988); Boelhouwers (1991a, 1991b); Lewis & Hanvey (1991)

Synopsis: **A** active & relict; **AASL** 1407-2249m; **SS** clovelly, silt, griffen, hutton, sand, clay & palaeosol; **M** sand

Solifluction

Solifluction is defined as the slow downslope flow of saturated unfrozen earth materials. The presence of a frozen substrate, or even freezing and thawing, is not implied in the original definition (slow flowing from higher to lower ground of waste saturated with water). However, one component of solifluction can be the creep of frozen ground. Rates of flow vary widely. The term is commonly applied to processes operating in both seasonal frost and permafrost areas (Andersson, 1906; Washburn, 1979). In contrast to gelifluction, solifluction does not require permafrost for its occurrence, but modern use of the term does imply the existence of cold climate conditions. It is a form of mass wasting faster than soil creep (0.5 to 5.0cm $year^{-1}$). Features produced by solifluction include uniform sheets of locally derived materials, tongue-shaped lobes, and alternating stripes of coarse and fine sediment. When associated with the active layer the term gelifluction should be used (Goudie *et al.*, 1985). Formerly solifluction was considered to be synonymous with soil creep (Clark, 1998).

...Solifluction-cont.

Synonym: solifluxion*

Publications: Sparrow (1967, 1971); Harper (1969); Hastenrath (1972); Hastenrath & Wilkinson (1973); Nicol (1973); Borchert & Sänger (1981); Sänger (1988); Marker (1989, 1992); Lewis & Hanvey (1991); Boelhouwers (1991a, 1991b, 1995a)

Synopsis: **A** active & relict; **AASL** 1181-3240m; **V** yes; **SN** sorted, nonsorted & stratified; **SS** chemically weathered, organic & unconsolidated dark, orange-brown & grey modern soil, gravel, grits, peat, silt, clay & a palaeosol; **M** sand & fines

Solifluctional phenomena characteristics: **W** <50; **L** 90cm-2,25km; **H** 17-93cm; **D** 6,1-35m

Solifluction apron A fan-like deposit at the base of a slope, produced by solifluction (Brown, 1969; Benedict, 1970; Washburn, 1979).

Solifluction deposit Geomorphological features of varying scale produced by the process of solifluction. Typical solifluction features include solifluction aprons, solifluction lobes (turf-banked lobes and stone-banked lobes), solifluction sheets and solifluction terraces (turf-banked terraces and stone-bankedterraces) (Brown, 1969; Benedict, 1970; Washburn, 1979).

Publications: with non-specific reference, Sparrow (1971); Nicol (1973); Lewis & Hanvey (1991)

Synopsis: **A** relict; **AASL** 1412-1998m; **V** yes; **SN** stratified; **SS** grits & gravel; **M** sand; **W** <50m; **D** 45m

Solifluction slump:

Publications: Sparrow (1967, 1971)

Synopsis: **A** relict; **AASL** 1675-3355m

Solifluction lobe An isolated, tongue-shaped solifluction feature, up to 25m wide and 150m or more long, formed by more rapid solifluction on certain sections of a slope showing variations in gradient. Commonly has a steep (15° to 60°) front and a relatively smooth upper surface. Solifluction lobes consist of *turf-banked lobes* and *stone-banked lobes* (Brown, 1969; Benedict, 1970; Washburn, 1979).

Synonym: mud-debris tongue*

Publications: Marker (1989, 1992)

Synopsis: **A** relict; **AASL** 1800-3200m; **L** 400m

Solifluction sheet A broad deposit of nonsorted, water-saturated, locally derived materials that is moving or has moved downslope. Sorted and/or nonsorted stripes are commonly associated with solifluction sheets (Brown, 1969; Benedict, 1970; Washburn, 1979).

Synonym: solifluction mantle

Publications: Hastenrath (1972)

Synopsis: **A** relict; **AASL** 2700m

Solifluction slump see Solifluction deposit

Solifluction terrace A low step, or bench, with a straight or lobate front, the latter reflecting local differences in the rate of solifluction movement. A solifluction terrace may have bare mineral soil on the upslope part and 'folded-under' organic matter in both the seasonally thawed ground and the frozen ground. Those covered with a vegetation mat are called *turf-banked (solifluction) terraces*; those that are stony are called *stone-banked (solifluction) terraces*.

Synonyms: solifluction bench, solifluction step, garland terrace*

Publications: Harper (1969); Marker (1989); Lewis (1996a)

Synopsis: **A** active & relict; **AASL** 2600-2744m; **V** yes; **SS** unconsolidated grey, orange & red sediments, modern soils & a palaeosol; **W** 50cm-10m; **L** 1m; **H** 1-20cm; **D** 6,1-12,2m

Solifluctional smoothing# The smoothing of a surface by solifluction processes.

Synonyms: solifluctional forming, solifluctional over-forming, slope smoothing, slope camouflaging:

Publications: Hastenrath (1972); Hastenrath & Wilkinson (1973); Marker (1989)

Synopsis: **A** relict; **AASL** 1181-3240m; **SS** subsoils

Sorted circle A patterned ground form that is equidimensional in several directions, with a dominantly circular outline, and a sorted appearance commonly due to a border of stones surrounding a central area of finer material. Sorted circles occur singly or in groups; their diameter is commonly between 0.5 and 3.0 m. Their central areas have a concentration of fines, with or without stones. The stones of the borders surrounding the central areas tend to increase in size with the size of the circles. Tabular stones tend to stand on edge, with their long axes in the vertical plane parallel to the border (Washburn, 1956).

Publications: Dardis & Granger (1986); Boelhouwers (1991a, 1994, 1995a)

Synopsis: **A** active; **AASL** 3140-3200m; **SN** sorted; **SS** modern soils; **W** 5cm-1.3m

Sorted net

A type of patterned ground with cells that are equidimensional in several directions, neither dominantly circular nor polygonal, with a sorted appearance commonly due to borders of stones surrounding central areas of finer material. Sorted nets occur most frequently on nearly horizontal surfaces. Diameters of individual cells range from 0.5m to 10m. Central areas have a concentration of fines, with or without stones. The bordering stones tend to increase in size with the size of the net (Washburn, 1979).

Publications: Hastenrath & Wilkinson (1973); Boelhouwers (1991a)

Synopsis: **A** active; **AASL** 1181-3200m; **SN** sorted; **W** 5-20cm

Sorted polygon

A patterned ground form that is equidimensional in several directions, with a dominantly polygonal outline, and a sorted appearance commonly due to a border of stones surrounding a central area of finer material. Sorted polygons commonly occur in extensive patterns, most frequently on nearly horizontal surfaces, and on slopes of less then 20°. They range in size from 10 cm to about 10 m. In places, small sorted polygons occur in the central areas of larger polygons. Central areas have a concentration of fines, with or without stones. The bordering stones tend to increase in size with the size of the polygons, but to decrease with depth, regardless of the size of the polygons (Washburn, 1956).

Publications: Harper (1969); Hastenrath & Wilkinson (1973); Lewis (1987); Hanvey & Marker, (1992); Boelhouwers (1991a, 1995a)

Synopsis: **A** active; **AASL** 2550-3300m; **SN** sorted; **SS** gritty modern soils & subsoils; **W** 5-20cm

Sorted step

A patterned ground feature with a step-like form and a downslope border of stones embanking an area of relatively fine-grained bare ground upslope. Sorted steps are only found on slopes ranging from 5° to 15°; their downslope border forms a low riser fronting a tread whose slope is less than the general slope. Sorted steps are presumed to be derived either from sorted circles or from sorted polygons, rather than to develop independently. Some sorted steps clearly form an intermediate stage between sorted polygons and sorted stripes (Washburn, 1979).

Synonym: stone garland

Sorted stripe

Sorted stripes form patterned ground with a striped and sorted appearance, due to parallel strips of stones and intervening strips of finer material, oriented down the steepest available slope. Sorted stripes, both large and small, occur on slopes of more than 3°, downslope from sorted polygons or sorted nets; they are derived by downslope extension of sorted polygons or sorted nets and can be several hundred metres long. The stones of the coarse stripes can range from pebbles to boulders, depending on the size of the stripes. The intervening finer material can be stone free or contain stones and be a diamicton (Washburn, 1956).

Publications: Lewis (1987); Boelhouwers (1991a, 1994, 1995a); Grab (1996b)

Synopsis: **A** active & relict; **AASL** 2800-3410m; **SN** sorted; **SS** clay, silt, gravels & a modern soil; **W** 5-20cm; **L** 1-3m

Stone-banked terrace

A solifluction terrace with a stony front (Brown, 1969; Benedict, 1970; Washburn, 1979).

Synonyms: stone-banked lobe, garland, stone-banked sheet

Publications: Dardis & Granger (1986); Boelhouwers (1991b, 1994, 1995a)

Synopsis: **A** active & relict; **AASL** 1600-3260m; **V** yes; **SN** sorted & nonsorted; **SS** modern soil; **W** 1cm-15m; **L** 90cm-60m; **H** 20cm-3m

Stripe

A form of patterned ground (see Patterned ground)

Publications: Lewis (1987); Hanvey & Marker (1992); Boelhouwers (1991a, 1994, 1995a); Grab (1996b)

Synopsis: **A** relict & active; **AASL** 2800-3410m; **V** yes; **SN** sorted & nonsorted; **SS** modern soil, clay, gravel, sand & silt; **W** 5cm-2m; **L** 1cm-10m

Surface creep

see Needle ice activity

Surface runoff

The flow of water on hillslopes. Sometimes referred to as storm runoff, direct runoff, or quickflow, it occurs when the infiltration capacity of the soil surface is exceeded, and the subsurface can no longer absorb moisture at the rate at which it is being supplied. Baseflow is the subsurface runoff made up of throughflow and/or groundwater whereas quickflow is a mixture of overland flow and subsurface stormflow. The precipitation collects in surface depressions and is briefly stored but when these depressions are filled, the water begins to flow downslope. As runoff proceeds down a slope, its overall form and process may change. As it begins its journey to the channel, it may move in a wide shallow sheet as sheet flow. When depths increase the water may begin to coalesce into small ephemeral channels called rills. As the water proceeds downslope, the channel flow in rills may coalesce into gullies. The amount of runoff is affected by land use, vegetation, and the porosity of the surface (Goudie *et al.*, 1985; Press & Siever, 1986; Kearey, 1996).

Synonym: runoff

Publications: Backéus (1989); Boelhouwers (1991a)

Synopsis: **A** active & relict; **AASL** 3200-3300m; **SS** humified, amorphous & chemically weathered peat, modern soils & subsoils

Terminal moraine

A sinuous ridge of unsorted glacial till deposited by a glacier at the terminus of a glacier (Press & Siever, 1986). Terminal moraines form at the toe of a small glacier (Goudie *et al.*, 1985; Lewis, 1996a).

Publications: Lewis (1996b)

Synopsis: **A** relict; **AASL** 1900-2000m

Terracette

One of a series of narrow horizontal steps from a few centimetres to 60cm in height, making a ribbed pattern on a steep, usually grassland, slope in areas accessible to animals. Their origin is disputed. They may owe their existence to soil creep and, once formed, be used by sheep and other animals; or they may have been formed initially by animals treading the easiest route up the hill (Clark, 1998; Kearey, 1996).

Synonym: cattle step[2]

Publications: Harper (1969); Hastenrath (1972); Hastenrath & Wilkinson (1973); Dardis & Granger (1986); Verster & Van Rooyen (1988); Watson (1988); Marker (1989); Boelhouwers (1991a); Hanvey & Marker (1992)

Synopsis: **A** active & relict; **AASL** all altitudes; **SN** nonsorted; **V** yes; **SS** silt, clay & modern soils, chemically weathered with high acidity; **W** 10cm-3.38m; **L** 10cm-34m; **H** 5cm-1.45m; **D** 15-35m

Turf-banked terracette

Publications: Boelhouwers (1991a)

Synopsis: **A** active **AASL** 3000-3120m; **V** yes; **W** 10-30cm; L 5-15m

Thawing (of frozen ground)

Melting of the ice in frozen ground, usually as a result of a rise in temperature (Van Everdingen, 1998).

Publications: Sparrow (1971)

Synopsis: **A** relict; **AASL** 1600m

Thufur

Perennial hummocks formed in either the active layer in permafrost areas, or in the seasonally frozen ground in non-permafrost areas, during freezing of the ground. Thufur (plural *thufa*) can be formed in the warmer part of the zone of discontinuous permafrost and also under conditions of maritime seasonal frost. The hummocks may be as much as 50cm in height and 160cm in diameter and can reform within 20 years following destruction. Growth is favoured by silty sediments, a maritime climate, and reasonably good drainage (Thorarinsson, 1951; Schunke, 1975; Scotter & Zoltai, 1982).

Synonyms: frost mound, hummock

Publications: Harper (1969); Marker & Whittington (1971); Hastenrath (1972); Hastenrath & Wilkinson (1973); Lewis (1987, 1996b); Boelhouwers (1991a); Hanvey & Marker

[2] Since the inception of the term, terracettes have been described in a number of different ways by various authors. Terminology used includes, amongst others, sheep roads (Warming, 1906, cited in Vincent & Clarke, 1980), cat steps (Bennet, 1938), sheep tracks (Dury, 1959) and cattle steps Boelhouwers, 1991a). Terms such as these directly imply genesis and are thus far from satisfactory since various modes of formation and sustaining mechanisms have been proposed, most suggesting a geomorphic origin rather than origins related to animal disturbance (Sinclair, 1998). Also see Boelhouwers (1988).

...Thufur-cont.

(1992, 1994); Grab (1994)

Synopsis: **A** active; **AASL** 2550-3270m; **V** yes; **SS** chemically weathered, gritty, organic & homogeneous dark modern soil, subsoil, clay, peat & silt; **W** 7-50cm; **Di** 20-98cm

Tor

An exposure of prominent, isolated mass of jointed, weathered rock, usually granite *in situ*, upstanding on all sides from the surrounding slopes formed by the differential weathering of a rock bed and the removal of the debris by mass movement (Pullan, 1959:54, as cited by Goudie *et al.*, 1985).

Publications: Sparrow (1964, 1967); Dardis & Granger (1986); Grab (1996a)

Synopsis: **A** active, relict; **AASL** 1675-3355m

Trough-like valley

see Trough valley

Trough valley

A valley with steep sides and truncated spurs and sometimes with steep upvalley termination (or trough's end) that grade into a flat floor usually eroded by a glacier (Press & Siever, 1986; Lewis, 1996a).

Synonym: U-shaped valley, trough

Trough-like valley:

Publications: Lewis (1996b)

Synopsis: **A** relict; **AASL** 2000m

Truncated spur

A spur which projected into the side of a pre-glacial valley until the valley became glaciated, when it was sharply cut and shortened by the glacier as it moved down the valley (Clark, 1998). Truncated spurs are caused by glacial erosion (Lewis, 1996a).

Publications: Lewis (1996b)

Synopsis: **A** relict; **AASL** 2000m

Turf-banked terracette

see Terracette

Turf exfoliation

Turf exfoliation, the weathering of turf by peeling off of the surface layers, occurs when eolian processes and cold temperatures in periglacial climates preclude vegetation cover or destroy it, and strong winds deflate bare bedrock and debris surfaces. Depending upon the particle sizes transported, the depositional phase of these periglacial eolian processes may range from cover sands to loess (Goudie *et al.*, 1985; Thorn, 1991; Kearey, 1996).

Publications: Hastenrath (1972); Boelhouwers (1991a); exfoliation: Hagedorn (1984)

Synopsis: **A** active; **AASL** 3000m

Turf-banked terrace

A solifluction lobe with its front covered by a vegetation mat (Brown, 1969; Benedict, 1970; Washburn, 1979).

Synonyms: turf-banked lobe, turf-banked step

Publications: Borchert & Sänger (1981); Dardis & Granger (1986); Boelhouwers (1991a, 1995a)

Synopsis: **A** active; **AASL** 1800-3120m; **V** yes; **SS** dark, heavy modern soil & clay; **W** 40cm-3m; **L** 1,82-6m; **H** 15-35cm

Valley asymmetry

A river valley or glacial valley of which one side is inclined at a different angle to the other (unequal slopes). Such a valley is a feature of periglacial areas where differences in aspect cause considerable differences in the strength of frost weathering and solifluction, but they can also be caused by structural circumstances (Goudie *et al.*, 1985; Press & Siever, 1986; Kearey, 1996).

Synonym: asymmetric valleys

Publications: Sparrow (1964, 1967); Harper (1969); Marker (1989); Meiklejohn (1992)

Synopsis: **A** relict; **AASL** 1675-3355m; **SS** chemically weathered & gritty modern soil & subsoil

Valley glacier

see Glacier

Vertical stacking

The slanting of a plate from the horizontal to the vertical (Clark, 1998).

Synonym: tilting and dislocation of plates

Publications: Hastenrath (1972); Hastenrath & Wilkinson (1973); Borchert & Sänger (1981)

Synopsis: **A** active; **AASL** 3073-3100m; **SS** fine sediments; **L** 50cm-1m

Not added to the glossary:

Dislocation (of stones)

Publications: Borchert & Sänger (1981)

Synopsis: **A** active; **AASL** 1900m

Gravel sorting

Publications: Hastenrath (1972)

Synopsis: **A** active; **AASL** 3100m; **SN** sorted

Planation surface

Paper: Sänger (1988)

Synopsis: **A** relict

Solution

Publications: Verster & Van Rooyen (!988)

Synopsis: **A** active; **SS** clovelly, griffen, hutton, clay & silt

Surface creep

Publications: Sänger (1988)

Synopsis: **A** active

APPENDIX D

Features and Processes Table

Features and Processes Table

A

FEATURES						
SECTION 1			SECTION 2			
Column 1 Category	**Column 2** Terminology used in database	**Column 3** Sub-categories	**Column 4** Terminology recognised by the IPA	**Column 5** Synonyms		**Column 6** Other
				Column 5.1 Synonyms recognised by the IPA	**Column 5.2** Synonyms not recommended by the IPA	
A. Accumulations of coarse debris	Blockfield	-	Blockfield	Stone field	Blockmeer Felsenmeer	Boulder field Rock-block field Rock river Rockstream
	Blockstream	-	-	-	-	-
	Boulder bed	-	-	-	-	-
	Debris	*Debris fan* *Debris mantle* *Debris ridge* *Scattered boulders*	- - - -	- - - -	- - - -	- - - -
	Rockglacier	Rockglacier	-	-	-	-
	Scree	Grèzes litées *Scree*	- -	- -	- -	Stratified scree Openwork block deposit Openwork debris deposit Talus
B. Periglacial ground features	Frozen ground	-	Frozen ground	-	-	-
	Ground ice	-	Ground ice	-	-	-
	Permafrost	-	Permafrost	Perennially frozen ground Perennially cryotic ground	Biennally frozen ground Climafrost Cryic layer Permanently frozen ground	-
C. Snow and ice features	*Basalt step*	-				
	Cryoplanation terrace	-	Cryoplanation terrace	-	-	-
	Ice-wedge cast	-	Ice-wedge cast	-	Fossil ice wedge Ice-wedge pseudomorph	-
	Needle ice	-	Needle ice	Pipkrake		-
	Segregation ice	-	Segregation ice	Segregated ice	Ice gneiss Sirlion ice Taber ice	-
	Snow patch	-	Snow patch	-	-	-

A

SECTION 1			SECTION 2			
Column 1 Category	**Column 2** Terminology used in database	**Column 3** Sub-categories	**Column 4** Terminology recognised by the IPA	**Column 5** Synonyms		**Column 6** Other
				Column 5.1 Synonyms recognised by the IPA	**Column 5.2** Synonyms not recommended by the IPA	
D. Solifluction features	Solifluction apron	-	Solifluction apron	-	-	-
	Solifluction deposit	-	Solifluction deposit	-	-	Solifluction slump
	Solifluction lobe	-	Solifluction lobe	-	Mud-debris tongue	-
	Solifluction sheet		Solifluction sheet	Solifluction mantle		
	Solifluction terrace		Solifluction terrace	Solifluction bench Solifluction step	Solifluction garland Garland terrace	
		Stone-banked terrace	Stone-banked terrace	-	-	Garland Stone-banked lobe Stone-banked sheet
		Turf-banked terrace	Turf-banked terrace	-	-	Earth garland Turf-banked lobe Turf-banked step
E. Patterned ground phenomena	Circle		Circle			Stone ring
	Nonsorted circle				Tundra hummock Earth mound Tundra hummock	
		Earth hummock	Earth hummock	Mud hummock		
		Mud circle	Mud circle	Mud boil		
		Stony earth circle	Stony earth circle			
		Thufur	Thufur			Frost mound Hummock
		Turf hummock	Turf hummock			
	Sorted circle	-	Sorted circle	-	-	-
	Net	-	Net	-	-	-
	Nonsorted net	-	Nonsorted net	-	-	-
	Sorted net	-	Sorted net	-	-	-
	Polygon	-	Polygon	Frost-crack polygon Frost polygon	Depressed centre polygon Fissure polygon Raised-centre polygon Taimyr polygon Tundra polygon	-
	Nonsorted polygon	-	Nonsorted polygon	-	-	-
	Sorted polygon	-	Sorted polygon	-	-	-
	Step	-	Step	-	-	-
	Nonsorted step	-	Nonsorted step	-	-	-
	Sorted step	-	Sorted step	Stone garland	-	-
	Stripe	-	Stripe			
	Sorted stripe	-	Sorted stripe	-	-	-
	Nonsorted stripe	-	Nonsorted stripe	-	-	-
	Patterned ground	-	Patterned ground	-	-	-

A

SECTION 1			SECTION 2			
Column 1 Category	**Column 2** Terminology used in database	**Column 3** Sub-categories	**Column 4** Terminology recognised by the IPA	**Column 5** Synonyms		**Column 6** Other
				Column 5.1 Synonyms recognised by the IPA	**Column 5.2** Synonyms not recommended by the IPA	
F. Gelifluction features	**Gelifluction apron**	-	-	-	-	-
	Gelifluction deposit	-	-	-	-	-
	Gelifluction head deposit	-	-	-	-	**Head**
	Gelifluction lobe	-	-	-	-	-
	Gelifluction sheet	-	-	-	-	**Gelifluction mantle**
	Gelifluction terrace	-	-	-	-	**Gelifluction bench** **Gelifluction step**
G. Glacial features	Arete	Arete	-	-	-	-
	Avalanche deposit	-	-	-	-	-
	Cutback	-	-	-	-	-
	Fluvioglacial deposition	-	-	-	-	-
	Glacial pavement	-	-	-	-	-
	Glacial polish	-	-	-	-	-
	Glaciers	Niche glacier Cirque glacier	-	-	-	-
	Glacial striation	-	-	-	-	Stria
	Glacier valleys	Hanging valley Trough valley	-	-	-	U-shaped valley U-shaped valley
	Moraines	Kame terrace Terminal moraine Kame moraine	-	-	-	End moraine Esker
	Roches moutonnées	-	-	-	-	-
	Truncated spur		-	-	-	-
H. Erosional hollows and associated features	*Erosional hollow*	Nivation niche	-	-	-	Amphitheatre-shaped hollow Cirque-like hollow Erosional hollow Smooth concave form Spoon-shaped valley end
	Nivation cirque	-	-	-	-	Nivation cirque
	Protalus rampart	-	-	-	-	Debris lobe Nival moraine Nivation moraine Pronival rampart Snowbank accumulation Snowbank deposit Snow slope detritus Winter talus ridge

A

SECTION 1			SECTION 2			
Column 1 Category	**Column 2** Terminology used in database	**Column 3** Sub-categories	**Column 4** Terminology recognised by the IPA	**Column 5** Synonyms		**Column 6** Other
				Column 5.1 Synonyms recognised by the IPA	**Column 5.2** Synonyms not recommended by the IPA	
	Cirque	-	-	-	-	Corrie Cwm Trough's end
I. Features formed after initial phase of deposition	*Channel system*	-	-	-	-	-
	Lacustrrine deposit	-	-	-	-	-
J. Soil profiles	*Compacted soil*	-	-	-	-	
	Palaeosol	-	-	-	-	Ancient soil Fossil soil Relict soil
	Permafrost layer	-	-	-	-	
K. Other features	*Flark*	-	-	-	-	-
	Hogsback	-	-	-	-	
	Lacustrine deposit	-	-	-	-	Lacustral deposit
	Pinnacle	-	-	-	-	Gendarme
	Pothole	-	-	-	-	-
	River terrace	-	-	-	-	-
	Terracette	-	-	-	-	Cattle step
	Tor	-	-	-	-	-
	*Valley asymmetry**	-	-	-	-	Asymmetric valley
	Vertical stacking	-	-	-	-	Tilting and dislocation of plates

Table A: Features identified in cold environments of southern Africa. Processes highlighted in italics are those features not necessarily characteristic of periglacial/glacial environments.

Periglacial phenomena

A Glacial phenomena

Other phenomena

*Asymmetric valleys (or valley asymmetry) are not recognised by the International Permafrost Association (IPA), but, according to Kearey (1996), valley asymmetry are quite common in periglacial environments where they form as a result of differences in slope aspect and solar radiation received.

B

PROCESSES					
SECTION 1		SECTION 2			
Column 1 Category	**Column 2** Term used in the database	**Column 3** Terms recognised by the IPA	**Column 4** Synonyms		**Column 5** Other
			Column 4.1 Synonyms recognised by the IPA	**Column 4.2** Synonyms not recognised by the IPA	
A. Freeze-thaw processes	Freezing (of ground)	Freezing (of ground)	-	-	-
	Freeze-thaw	Freeze-thaw	-	-	Gelifraction
	Periglacial process	Periglacial process	-	-	-
Cryoturbation	Cryoturbation	Cryoturbates	Congeliturbation Frost churning Frost stirring	Geliturbation	-
	Cryogenic process	Cryogneic process	-	-	-
	Cryoplanation	Cryoplanation	-	-	-
	Frost action	Frost action	Frost riving Frost wedging Gelifraction	-	-
	Frost creep	Frost creep			-
	Frost heave	Frost heave		Frost thrust	-
	Frost shattering	Frost shattering	(Con-)gelifraction Frost splitting Frost weathering	-	-
	Frost sorting	Frost sorting		-	-
	Frost wedging	Frost wedging	Congelifraction Frost bursting Frost prying Frost riving Frost splitting	-	-
	Ice segregation	Ice segregation	-	-	Ice lensing
	Ice	Ice	-	-	
	Needle ice activity	Needle ice activity Surface creep	-	-	Needle ice stripe Raked ground Raked pattern Striated soil -
	Nivation*	-	-	-	-
C. Gelifluction processes	Gelifluction	Gelifluction	-	-	-
	Inversion of the weathering profile	-	-	-	-
	Geliflual action	-	-	-	-
D. Solifluction processes	Solifluction	Solifluction	-	-	Solifluxion
	Solifluctional smoothing	-	-	-	Solifluctional forming Solifluctional over-forming

B

PROCESSES					
SECTION 1		SECTION 2			
Column 1 Category	**Column 2** Term used in the database	**Column 3** Terms recognised by the IPA	**Column 4** Synonyms		**Column 5** Other
			Column 4.1 Synonyms recognised by the IPA	**Column 4.2** Synonyms not recognised by the IPA	
E. Glacial processes	Avalanching	-	-	-	-
	Fluvio-glacial	-	-	-	-
	Fluvio-glacial deposition	-	-	-	-
	Glacial action	-	-	-	Glacial movement Glacial erosion
	Glacial erosion	-	-	-	-
	Glacial polishing	-	-	-	-
F. Fluvial action	*Fluvial*	-	-	-	Fluviatile
	Surface runoff	-	-	-	Runoff
G. Soil and mass movement	*Debris flow*	-	-	-	-
	Emplacement (by slow flow)	-	-	-	Differential mass displacement
	Mass movement	-	-	-	Downslope sludging of individual stones Mass wasting Mass flow Slow mass movement
	Soil creep	-	-	-	Soil flow
	Sheet wash	-	-	-	Sheet-flow
H. Other processes	Contraction	-	-	-	-
	Desiccation	-	-	-	-
	Diurnal oscillation	-	-	-	-
	Erosion	-	-	-	-
	Grazing animals	-	-	-	-
	Turf exfoliation	-	-	-	-

Table B: Processes identified in cold environments of southern Africa. Processes highlighted in Italics are those processes not necessarily characteristic of periglacial/ glacial environments.

Periglacial phenomena

A Glacial phenomena

Other phenomena

* The process of nivation is not recognised by the IPA as a periglacial process.

TABLE A	
Contents of column 1	
A. Accumulations of coarse debris	Features consisting of accumulations of coarse debris, such as clasts, and that take on a certain characteristic shape that may be indicative of periglacial activity.
B. Periglacial ground features	Features that are characteristic of frozen ground.
C. Snow and ice features	Features of which formation is closely linked with snow and/or ice.
D. Solifluction features	Features that form through slow downslope flow of saturated unfrozen earth materials (Van Everdingen, 1998), but not necessarily the result of movement over frozen substrate.
E. Patterned ground phenomena	Any ground surface phenomena exhibiting a discernible ordered, more or less symmetrical, morphological pattern of ground, vegetation and rock fragments, defined as circles, stripes, polygons and nets (Van Everdingen, 1998).
F. Gelifluction features	Features forming through slow flowage of unfrozen earth materials on a frozen substrate (e.g. permafrost).
G. Glacial features	Features that were formed by glacial processes and glacier movement.
H. Erosional hollows and associated features	Features that formed through snow and/or ice action, displaying a concave shape, and features that are usually associated with hollow formation (e.g. protalus ramparts).
I. Features formed after initial phase of deposition	Features that were formed after the initial phase of periglacial or glacial deposition. These features may be polygenetic in origin.
J. Soil profiles	The vertical sequence of soil horizons.
H. Other features	Other features associated with, but not exclusively to, periglacial or glacial action.

TABLE B	
Contents of column 1	
A. Freeze-thaw processes	Processes associated with the changing phase from water to ice and vice versa in soil or rock (Van Everdingen, 1998).
B. Cryoturbation	Soil movements due to frost action (Van Everdingen, 1998).
C. Gelifluction processes	Processes of slow downslope flow or unfrozen earth materials on a frozen substrate (e.g. permafrost) (Van Everdingen, 1998).
D. Solifluction processes	Processes of slow downslope flow or saturated earth materials, but not requiring a frozen substrate (Goudie *et al.*, 1985; Van Everdingen, 1998).
E. Glacial processes	The action and processes that take place where a landscape is occupied by glaciers.
F. Fluvial action	The action of a river, its flow, depositional and erosive activity (Clark, 1998).
G. Soil and mass movement	Processes of downward movement of rock materials and soil.
H. Other processes	Other processes associated with periglacial action, but not necessarily of such origin.

APPENDIX E

General Features and Processes Reference Index

Abbreviations

A	Activity of phenomenon, i.e. whether it is still active or not
AASL	Altitude above sea level
D	Depth range of a phenomenon
Di	Diameter of phenomenon
H	Height range of a phenomenon
L	Length range of a phenomenon
M	The type of matrix present in a matrix supported phenomenon
SN	Sorted, nonsorted or stratified
SS	Soils and sediments present within, under or in the vicinity of the phenomenon in question
V	Vegetated
W	Width range of a phenomenon

General Features and Processes Reference Index

Phenomena	Publications	A	AASL	V	SN	SS	M	W (m)	L (m)	H (m)	D (m)
Aréte	Sparrow (1964, 1967b) Sänger (1988)	R	-	-	-	-	-	-	-	-	-
Avalanching	Sparrow (1964) Grab (1996b)	R	3200-3300	-	-	humic	-	-	-	-	-
Avalanche deposit	Lewis & Dardis (1985)	R	-	-	-	-	sand	-	-	-	1,5-1,8
Basalt step	Harper (1969)	R	3230-3325	-	-	chemically weathered modern soil & subsoils	-	-	-	1,8-6,1	-
Blocfield	Linton (1969) Sparrow (1971) Borchert & Sänger (1981) Sänger (1988) Marker (1992) Boelhouwers (1994) Grab (1996a)	R	1500-3260	-	-	-	-	30	25	-	1-7
Blockstream	Hastenrath & Wilkinson (1973) Hagedorn (1984) Lewis (1996a)	R	-	-	-	-	-	10-30	100	4-8	-
Boulder bed	Sparrow (1973) Grab (1996a)	R	1675-3355	-	-	-	-	-	100	1-5	Di: 1
Channel system	Hall (1994)	R	2100	-	-	-	-	100	1000	10	-
Cirque	Sparrow (1967a, 1967b) Harper (1969) Borchert & Sänger (1981) Sänger (1988) Lewis (1996b)	R	1675-3355	-	-	chemically weathered, gritty modern soils & subsoils	-	15,25	-	-	-
Cirque-like hollow	Sparrow (1964) Dyer & Marker (1979)	R	2607-3204	-	-	peat	-	621-1166,7	486-1071,4	93-280	96-230
Cirque glacier	Borchert & Sänger (1981) Sänger (1988)	R	1900	-	-	-	-	-	-	-	-
Clast*	Hanvey & Marker (1992)	A	3275	-	-	-	-	-	-	-	-
Compacted soil	Fitzpatrick (1978)	R	-	-	-	orthic, humic, yellow, brown, grey, black magwa, clovelly, silt-loam	-	-	-	-	-
Contraction	Dyer & Marker (1979)	R	2870-3070	-	-	-	-	-	-	-	-
Corrie sheet	Borchert & Sänger (1981)	R	1900	-	-	-	-	-	-	-	-

Phenomena	Publications	A	AASL	V	SN	SS	M	W (m)	L (m)	H (m)	D (m)
Cryogenic process	Meiklejohn (1992) Boelhouwers (1994) Hanvey & Marker (1994) Marker (1995b)	R A	1850-3250	-	-	humic, massive, organic peat, silt, graveks, modern soils, palaeosols	-	-	-	-	-
Cryoplanation terrace	Hagedorn (1984)	R	1800-2370	-	-	-	-	700-2000	2000	2	-
Cryoturbation	Borchert & Sänger (1981) Lewis & Dardis (1985)	R A	3200-3377	-	-	subsoils	-	-	-	-	-
Cryoturbation features	Borchert & Sänger (1981)	A	1900	-	-	-	-	-	-	-	-
Cutback	Hall (1994) Grab (1996a)	R	2968-3377	-	-	-	-	-	-	-	-
Debris deposit	Lewis (1996a)	R	1930	-	-	-	-	-	400	-	-
Debris fan	Lewis & Hanvey (1991)	R	1407-1648	-	S	fine black sand, palaeosols	sand, gravel	-	-	20-22	-
Debris flow	Hanvey *et al.* (1986) Lewis & Hanvey (1988) Hall (1994)	R	1900	-	-	-	-	-	-	-	-
Debris mantle	Boelhouwers (1991b)	A	1800	-	N	-	diamicton	-	-	-	-
Debris ridge	Lewis & Hanvey (1993) Grab (1996b)	R	3200-3250	-	-	humic	-	-	18,4-747,35	-	-
Desiccation	Hanvey & Marker (1992)	R	2870-3070	-	-	peat	-	-	-	-	-
Desiccatoin polygon	Hanvey & Marker (1992)	A	3275	-	-	-	-	-	-	-	**Di**: 0,15-1
Emplacement	Marker (1992)	A	2300-2800	-	-	-	-	-	-	-	-
Erosion	Harper (1969) Marker & Whittington (1971) Marker (1992) Meiklejohn (1992) Hanvey & Marker (1994)	R	1500-3325	-	-	chemically weathered modern soil, subsoil	-	-	-	-	-
Erosional hollow	Sparrow (1964) Harper (1969) Marker & Whittington (1971) Hastenrath (1972) Hastenrath & Wilkinson (1973) Nicol (1973) Dyer & Marker (1979) Borchert & Sänger (1981) Lewis & Hanvey (1988) Marker (1989, 1990c, 1991b) Hanvey & Marker (1994)	R	1600-3355	-	-	yellow to dark peats, gravels, clays, unconsolidated, oxidised modern soils	gravels, clasts	400-2500	400-2250	21-293	93-1207

Phenomena	Publications	A	AASL	V	SN	SS	M	W (m)	L (m)	H (m)	D (m)
Flark	Backéus (1989)	A	3200-3300	Y	-	humified, amorphous peat	-	-	15	-	0,2-0,6
Fluvial	Lewis & Dardis (1985) Lewis & Hanvey (1991) Meiklejohn (1992)	R A	1675-3355	-	-	-	-	-	-	-	-
Fluvio-glacial deposit(-ion)	Hall (1994) Grab (1996a) Lewis (1996b)	R	2000-3200	-	-	sand, clay, palaeosol	-	100	100-3000	1-20	-
Fluvio-glacial meltwater	Hanvey *et al.* (1986)	R	2225-2340	-	-	massive, structured sand, clay, silt	massive	-	-	-	-
Freeze-thaw	Harper (1969) Marker & whittington (1971) Sparrow (1971) Fitzpatrick (1978) Hanvey & Marker (1992)	A	1788-3295	-	-	-	-	-	-	-	-
Freezing	Boelhouwers (1995a)	A	1407-3355	-	-	organic peat, light black fine sand, palaeosols, modern soils	gravels	-	-	-	-
Frost action	Sparrow (1967a) Harper (1969) Hastenrath (1972) Hastenrath & Wilkinson (1973) Fitzpatrick (1978) Borchert & Sänger (1981) Hanvey *et al.* (1986) Marker (1986) Lewis (1987, 1996a) Lewis & Hanvey (1988) Hanvey & Lewis (1991) Grab (1994)	A R	1582-3355	-	-	humic, massive, homogeneous, organic clovelly, magwa, black, brown, yellow, grey clay, sand, silt, loam	-	-	-	-	-
Frost climate	Borchert & Sänger (1981)	R	1900	-	-	-	-	-	-	-	-
Frost creep	Lewis & Dardis (1985) Hanvey & Marker (1992) Boelhouwers (1991a, 1994, 1995a)	A	1800-3260	-	-	-	mud	-	-	-	-
Frost heave	Hastenrath (1972) Dardis & Granger (1986) Lewis (1987) Hanvey & Marker (1992) Boelhouwers (1995a) Grab (1996b)	A	3200	-	-	-	-	-	-	-	-

Phenomena	Publications	A	AASL	V	SN	SS	M	W (m)	L (m)	H (m)	D (m)
Frost shattering	Harper (1969) Hagedorn (1984) Sänger (1988) Marker (1989) Hanvey & Marker (1992) Lewis & Hanvey (1993)	A	3200	-	-	-	-	-	-	-	-
Frost sorting	Boelhouwers (1994)	R	3140-3260	-	S	-	-	2m	-	-	-
Frost wedging	Sparrow (1967a) Harper (1969) Hastenrath & Wilkinson (1973) Borchert & Sänger (1981)	A R	1900-2530	-	-	modern subsoils	-	-	-	-	-
Frozen ground	Harper (1969) Borchert & Sänger (1981) Lewis & Dardis (1985) Dardis & Granger (1986) Lewis (1987) Boelhouwers (1995a)	A	2744-3200	-	S	clay, palaeosol	mud, diamicton	-	-	-	-
Frozen ground phenomena#	Borchert & Sänger (1981)	R	1900	-	-	-	-	-	-	-	-
Geliflual action	Linton (1969)	R	445-2000	-	-	grey, red, brown modern soil, gravel	brown earth, sand, grits	-	-	-	-
Geliflual apron	Linton (1969)	R	445-2000	Y	-	grey, red, brown modern soil, gravel	brown earth, sand, grits	-	-	-	1-8
Geliflual deposit	Linton (1969)	R	445	Y	-	grey-buff modern soils, gravel	rusty coloured chips	-	-	-	8
Gelifluction	Harper (1969) Linton (1969) Lewis & Dardis (1985) Dardis & Granger (1986) Lewis (1987, 1996a) Hanvey & Marker (1992) Boelhouwers (1994)	A	445-3260	-	-	-	mud, chips	-	-	-	-
Gelifluction deposit	Linton (1969) Lewis & Dardis (1985) Lewis (1987)	R	445-2000	-	S	-	sand, mud	-	-	-	0,3-8
Gelifluction (head) deposit	Nicol (1973)	R	1841-2000	Y	Strat	grits, sand, gravels, palaeosol	-	-	-	-	15
Gelifluction sheet	Boelhouwers (1994)	R	3140-3260	-	S	-	-	10	<20	<0,5	-
Gelisolifluction	Hagedorn (1984)	R	1700-2370	-	-	-	-	-	-	-	-

Phenomena	Publications	A	AASL	V	SN	SS	M	W (m)	L (m)	H (m)	D (m)
Glacial	Sänger (1988) Hanvey & Lewis (1990) Marker (1991b) Lewis & Hanvey (1993)	R	1850-2135	-	-	sand, clay, mud, silt	-	-	-	-	-
Glacial phenomena	Harper (1969) Borchert & Sänger (1981) Sänger (1988) Hanvey & Lewis (1990) Marker (1991b) Lewis & Hanvey (1993) Hall (1994) Grab (1996a) Lewis (1996b)	R	1820-3377	Y	Strat	peat, silt, clay, sand, palaeosol	sand, gravel, mud	-	-	-	-
Glaciation	Grab (1996a)	R	3200-3300	-	-	-	-	-	-	-	-
Glacial erosion	Harper (1969) Borchert & Sänger (1981) Lewis & Hanvey (1993) Lewis (1996b)	R	1820-2350	-	-	chemically weathered, gritty, koalinised, organic modern soil, subsoil, palaeosol	sand, silt, gravel	-	-	-	-
Glacial meltwater	Hanvey *et al.* (1986)	R	2225-2340	-	-	massive structured sand clay, silt	massive	-	-	-	-
Glacial pavement	Sänger (1988)	R	-	-	-	-	-	-	-	-	-
Glacial pebble	Sänger (1988)	R		-	-	-	-	-	-	-	-
Glacial phenomena		R	1820-3377	Y	Strat	peat, silt, clay, sand, palaeosol	sand, gravel, mud	-	-	-	-
Glacial polish	Harper (1969) Borchert & Sänger (1981) Sänger (1988)	R	1900-2350	-	-	chemically weathered gritty modern soil, subsoil	-	-	-	-	-
Glacial striation	Borchert & Sänger (1981) Sänger (1988) Lewis (1996b)	R	1900-2500	-	-	-	-	-	-	-	-
Glaciation	Grab (1996b)	R	3200-3300	-	-	-	-	-	-	-	-
Glacier	Borchert & Sänger (1981)	R	1900	-	-	in situ koalinised granit soil	sand	-	-	-	-
Gravel sorting	Hastenrath (1972)	A R	3100	-	S	-	-	-	-	-	-
Grèzes littées	Lewis & Dardis (1985) Lewis & Hanvey (1988)	R	-	-	S	-	mud, silt, sand	-	-	-	-
Ground freeze	Boelhouwers (1995)	A	1800-1850	Y	S	modern soil	-	-	-	-	-
Ground ice	Hanvey & Marker (1992)	A	3275	-	-	-	-	-	-	-	-
Hanging valley	Lewis (1996b)	R	2000	-	-	-	-	-	-	-	-
Hogsback	Borchert & Sänger (1981)	R	19 00	-	-	-	-	-	-	-	-

Phenomena	Publications	A	AASL	V	SN	SS	M	W (m)	L (m)	H (m)	D (m)
Ice shattered ridge	Sparrow (1967a)	R	1675-3355	-	-	-	-	-	-	-	-
Ice stripped areas	Sparrow (1967a)	R	1675-3355	-	-	-	-	-	-	-	-
Ice wedge	Harper (1969) Lewis (1996a)	A	3050	-	-	gritty modern soil, subsoil	-	0,05-0,1	-	-	0,61
Ice-wedge cast	Lewis & Dardis (1985) Lewis (1996a)	R	1850	-	-	fine sediment, palaeosol	-	0,2-0,4	-	-	1-1,8
Ice-stripped area	Sparrow (1967a)	R	1675-3355	-	-	-	-	-	-	-	-
Inversion of the weathering profiel	Linton (1969)	R	1200	-	-	sands, grits	sand, grits	-	-	-	-
Kame moraine	Lewis (1996b)	R	2000	-	-	-	-	100	-	-	-
Kame terrace	Lewis (1996b)	R	2000	-	-	sand, palaeosol, gravel	-	-	3000	20	-
Lacustrine deposit	Hanvey & Lewis (1990)	R	1850	-	Strat	massive, organic, laminated silt, gavel, sandstone	mud, sand	-	60	16	-
Mass movement	Marker (1992) Hanvey & Marker (1994)	-	3000-3250	-	S	subsoil					
Moraine	Sparrow (1967a) Borchert & Sänger (1981) Sänger (1988) Lewis (1996b)	R	1900	-	-	-	-	-	-	-	-
Moraine sheet	Borchert & Sänger (1981)	R	1900	-	-	-	-	-	-	-	-
Needle ice	Hastenrath (1972) Hastenrath & Wilkinson (1973) Lewis (1987) Sänger (1988) Verster & Van Rooyen (1988) Marker (1989) Boelhouwers (1991a) Hanvey & Marker (1992) Grab (1996b)	A	1800-3410	-	-	-	-	-	-	0,05	-
Needle ice activity	Hastenrath & Wilkinson (1973) Lewis (1987) Sänger (1988) Marker (1989) Boelhouwers (1991a) Hanvey & Marker (1992) Grab (1996b)	A	1800-3410	-	-	-	-	-	-	-	-
Net	Hastenrath & Wilkinson (1973) Boelhouwers (1991a)	A	1181-3200	-	S	-	-	0,05-0,2	-	-	-
Niche (hollow)	Marker (1991b) Grab (1996a)	R	3295-3377	-	-	-	-	-	-	-	-
Niche glacier	Hall (1994)	R	-	-	-	-	-	-	-	-	-

Phenomena	Publications	A	AASL	V	SN	SS	M	W (m)	L (m)	H (m)	D (m)
Nivation	Sparrow (1967a) Harper (1969) Nicol (1973) Dyer & Marker (1979) Borchert & Sänger (1981) Lewis & Hanvey (1988) Marker (1986, 1989, 1990b) Hanvey & Lewis (1991) Hall (1994) Lewis (1994, 1996b)	R	1675-3355	-	-	sand, modern soil	silt, clay	-	-	-	-
Nivation niche	Harper (1969) Marker (1989)	R	1800-2837	Y	-	-	-	-	-	-	-
Nonsorted circle	Harper (1969) Hastenrath & Wilkinson (1973) Borchert & Sänger (1981) Boelhouwers (1991a)	A	1181-3354	Y	N	gritty modern soils, subsoils	-	0,4	-	-	**Di**: 0,2-0,6
Nonsorted polygon	Harper (1969) Hastenrath (1972) Lewis (1987, 1996b) Hanvey & Marker (1992)	A	2900-3354	-	N	gritty modern soil	-	0,06-0,2	-	-	-
Palaeosol	Harper (1969) Lewis & Hanvey (1991, 1993) Hanvey & Marker (1994) Marker (1995b) Lewis (1996a)	R	1407-3175	Y	-	brown	-	-	-	-	0,4-2,5
Patterned ground	Harper (1969) Hastenrath (1972) Hastenrath & Wilkinson (1973) Borchert & Sänger (1981) Dardis & Granger (1986) Lewis (1987, 1996a) Boelhouwers (1991a, 1994, 1995a) Hanvey & Marker (1992) Grab (1996b)	A R	1181-3210	-	S N	chemically weathered, gritty modern soils, subsoils, clays, silts, sands & gravels	-	0,06-2	0,01-10	-	**Di** 0,15-6
Pebble (glacially modified)	Sänger (1988)	R	-	-	-	-	-	-	-	-	-

Phenomena	Publications	A	AASL	V	SN	SS	M	W (m)	L (m)	H (m)	D (m)
Periglacial process	Sparrow (1964) Hastenrath (1972) Borchert & Sänger (1981) Hagedorn (1984) Lewis & Hanvey (1988) Marker (1989) Hanvey & Marker (1992)	A R	1700-3200	-	-	subsoil	-	-	-	-	-
Periglacial slope wash	Lewis & Hanvey (1988)	R	-	-	-	-	sand, silt	-	-	-	-
Permafrost	Boelhouwers (1994)	R	-	-	-	-	-	-	-	-	-
Permafrost layer	Fitzpatrick (1979) Lewis (1996a)	R	2500	-	Strat	orthic, humic, yellow, brown, black magwa, clovelly, silt	-	-	-	-	-
Permafrost process	Lewis (1996a)	R	1930	-	-	-	-	-	-	-	-
Pinnacle	Borchert & Sänger (1981)	R	1900	-	-	-	-	-	-	-	-
Plateau glacier	Sänger (1988)	R	-	-	-	-	-	-	-	-	-
Planation surface	Sänger (1988)	R	-	-	-	-	-	-	-	-	-
Polygon	Harper (1969) Hastenrath (1972) Hastenrath & Wilkinson (1973) Lewis (1987, 1996a) Hanvey & Marker (1992) Boelhouwers (1991a, 1995a)	A R	2550-3355	-	S N	chemically weathered, gritty modern soil, subsoil	-	0,04-0,2	-	-	**Di** 0,15-6
Pothole	Sänger (1988)	R	-	-	-	-	-	-	-	-	-
Protalus rampart	Nicol (1973) Marker (1989, 1990b, 1990c) Lewis (1994, 1996a)	R	1800-2837	Y	-	-	-	52-83	217-1500	8,5-104	8-16 **Di**: 27-69
River terrace	Lewis & Hanvey (1991)	R	1407-1607m	-	-	sand, gravel	-	-	-	-	-
Roché mountonée	Grab (1996a)	R	2968-3377	-	-	-	-	-	-	-	-
Rockglacier	Lewis & Hanvey (1993) Lewis (1996a)	R	-	S	-	organic, palaeosols	sand, silts, clays	30-250	200-550	4-30	-
Scree	Sparrow (1967a) Marker (1986, 1992) Lewis (1994) Sumner & De Villiers (*in prep*)	R	1582-3355	Y	-	-	-	37-75	100-235	1-3	-
Segregation ice	Boelhouwers (1994) Grab (1996b)	A	3140-3410	-	-	-	-	-	-	-	-
Sheet-wash	Lewis & Dardis (1985) Watson (1988)	A R	-	-	-	hutton	-	-	-	-	-

Phenomena	Publications	A	AASL	V	SN	SS	M	W (m)	L (m)	H (m)	D (m)
Sheet-wash (-flow)	Lewis & Dardis (1985) Watson (1988)	A R	-	Y	S	acid leached, weathered hutton, griffen, mispah-glenrosa	mud, sand	-	-	-	-
Slip scar	Harper (1969)	A	2530-3000	Y	-	chemically weathered, gritty modern soil, subsoil	-	-	-	-	-
Snow patch (conditions)	Sparrow (1967a, 1973) Nicol (1973) Dyer & Marker (1979) Marker (1990) Lewis (1994)	R	1675-3355	-	-	-	-	-	-	-	-
Snowpatch meltwater	Marker (1989)	R	1800-2837	-	-	-	-	-	-	-	-
Slope weathering	Hanvey & Marker (1994)		3000-3250	-	-	brown to dark gravels, peat, palaeosol, silt, modern soil	-	-	-	-	-
Soil creep	Borchert & Sänger (1981) Verster & Van Rooyen (1988) Boelhouwers (1991a, 1991b) Lewis & Hanvey (1991)	A R	1407-2249	-		clovelly, silt, griffen, palaesol, hutton, sand, clay	sand	-	-	-	-
Solifluction	Sparrow (1967a, 1971) Harper (1969) Hastenrath (1972) Hastenrath & Wilkinson (1973) Nicol (1973) Borchert & Sänger (1981) Sänger (1988) Marker (1989) Lewis & Hanvey (1991) Meiklejohn (1992) Boelhouwers (1991b, 1995a)	A R	1181-3240	Y	S N Strat	chemically weathered, organic, unconsolidated dark, orange-brown, grey modern soil, gravels. grits, peat, silt, clay, palaeosol	sand, fines	-	-	-	-
Solifluction deposit	Sparrow (1971) Lewis & Hanvey (1991)	R	1412-1998	Y	Strat	grits, gravel	sand	<50	-	-	45
Solifluction lobe	Marker (1989, 1992)	R	1800-2837	-	-	-	-	-	-	-	-
Solifluction phenomena	Sparrow (1967a, 1971) Harper (1969) Hastenrath (1972) Hastenrath & Wilkinson (1973) Nicol (1973) Borchert & Sänger (1981) Sänger (1988) Meiklejohn (1992) Hanvey & Marker (1994) Boelhouwers (1991a, 1991b, 1995a)	A R	1181-3240	Y	S N Strat	chemically weathered, organic, unconsolidated dark, orange-brown, grey modern soil, gravels. grits, peat, silt, clay, palaeosol	sand, fines	<50	0,9-2250	0,17-9,93	6,1-35

Phenomena	Publications	A	AASL	V	SN	SS	M	W (m)	L (m)	H (m)	D (m)
Solifluction sheet	Hastenrath (1972)	R	2700	-	-	-	-	-	-	-	-
Solifluction slump	Sparrow (1967a, 1971) Harper (1969)	R	1675-3355	-	-	-	-	-	-	-	-
Solifluctional smoothing	Hastenrath & Wilkinson (1973) Marker (1989)	R	1181-3100	-	-	subsoil	-	-	-	-	-
Solifluction terrace	Harper (1969) Marker (1989) Lewis (1996a)	A R	2600-2744	Y	-	chemically weathered, unconsolidated, grey, orange, red sediments, palaeosol, modern soil	-	0,5-10	1	0,01-0,2	6,1-12,2
Solution	Verster & Van Rooyen (1988)	A	-	-	-	clovelly, griffen, hutton, clay, silt	-	-	-	-	-
Sorted circle	Dardis & Granger (1985) Boelhouwers (1991a, 1994, 1995a)	A	3140-3200	-	S	modern soils	-	0,05-1,3	-	-	-
Sorted net	Hastenrath & Wilkinson (1973) Boelhouwers (1991a)	A	1181-3200	-	S	-	-	0,05-0,2	-	-	-
Sorted polygon	Harper (1969) Hastenrath & Wilkinson (1973) Lewis (1987) Hanvey & Marker (1992) Boelhouwers (1991a, 1995a)	A	2250-3300	-	S	gritty modern soils, subsoils	-	0,05-0,2	-	-	-
Sorted stripe	Lewis (1987) Boelhouwers (1991a, 1994, 1995a) Grab (1996b)	A R	2800-3410	-	S	clay, silt, gravels, modern soil	-	0,05-2	-	-	-
Stone-banked terrace	Dardis & Granger (1986) Boelhouwers (1991b, 1994, 1995a)	A R	1600-3260	Y	S N	modern soil	-	0,01-15	0,9-60	0,2-3	-
Stripe	Lewis (1987) Hanvey & Marker (1992) Boelhouwers (1991a, 1994, 1995a) Grab (1996b)	A R	2800-3410	Y	S N	modern soil, clay, gravel, sand, silt	-	0,05-2	0,01-10	-	-
Surface creep	Sänger (1988)	A	-	-	-	-	-	-	-	-	-
Surface runoff	Harper (1969) Backéus (1989) Boelhouwers (1991a)	A R	3200-3300	-	-	humified, amorphous, chemically weathered peat, modern soil, subsoils	-	-	-	-	-

Phenomena	Publications	A	AASL	V	SN	SS	M	W (m)	L (m)	H (m)	D (m)
Terminal moraine	Lewis (1996b)	R	1900-2000	-	-	-	-	-	-	-	-
Terrace	Marker (1989)	R	1800-2837	-	N	-	-	-	-	-	15-35
Terracette	Harper (1969) Hastenrath (1972) Hastenrath & Wilkinson (1973) Dardis & Granger (1986) Verster & Van Rooyen (1988) Watson (1988) Marker (1989) Boelhouwers (1991a) Hanvey & Marker (1992)	A	all altitudes	-	N	silt, clay and modern soils, chemically weathered with high acidity	-	0,1-3,83	0,1-34	0,05-1,45	-
Thawing	Sparrow (1971)	R	1600	-	-	-	-	-	-	-	-
Thufur	Harper (1969) Marker & Whittington (1971) Hastenrath (1972) Hastenrath & Wilkinson (1973) Lewis (1987, 1996a) Boelhouwers (1991a) Hanvey & Marker (1992, 1994) Grab (1994)	A	2550-3270	Y	-	chemically weathered, gritty, organic, homogeneous dark modern soil, subsoil, clay, peat, silt	-	0,07-0,5	-	-	Di 0,2-0,98
Tor	Sparrow (1964, 1967a) Dardis & Granger (1986) Grab (1996a)	A R	1675-3355	-	-	-	-	-	-	-	-
Trough-like valley	Lewis (1996b)	R	2000	-	-	-	-	-	-	-	-
Truncated spur	Lewis (1996b)	R	2000	-	-	-	-	-	-	-	-
Turf exfoliation	Hastenrath (1972) Boelhouwers (1991a)	A	3000	-	-	-	-	-	-	-	-
Turf-banked terrace	Borchert & Sänger (1981) Dardis & Granger (1986) Boelhouwers (1991a, 1995a)	A	1800-3120	Y	-	dark, heavy modern soil, clay	-	0,4-3	1,82-6	0,15-0,35	-
Valley asymmetry	Sparrow (1964, 1967a) Harper (1969) Marker (1989) Meiklejohn (1992)	R	1675-3355	-	-	chemically weathered, gritty modern soil, subsoil	-	-	-	-	-
Valley glacier	Sänger (1988)	R	-	-	-	-	-	-	-	-	-
Vertical stacking	Hastenrath (1972) Hastenrath & wilkinson (1973)	A	3073-3100	-	-	fine sediment	-	-	0,5-1	-	-

APPENDIX F

Geographic Location Reference Index

Geographic Location Reference List

Phenomenon	Location	Province/District/ Region	Latitude (S)	Longitude (E)
Arêtes	East Griqualand	Kwa-Zulu Natal		
	HDALM	HDALM		
	Ingeli (Ngeli)	HDALM	30°37'59"	29°17'39"
	Insizwa (Ntsizwa)	HDALM	30°47'11"	29°12'19"
	Mount Currie	Old Transkei	30°28'22"	29°25'16"
	Western Cape Mts.	Western Cape		
Avalanche deposit	Dynevor Park	Eastern Cape	31°08'44"	27°47'05"
Avalanching	Kwa Ntuba	HDALM	29°31'05"	29°17'58"
	Nhlangeni	HDALM	29°29'15"	29°18'54"
	Ntabamnyama	HDALM	29°10'26"	29°28'07"
	Ship's Prow	HDALM	29°05'45"	29°20'01"
Basalt steps	HDALM	HDALM		
	Injasuthi (Njesuthi)	HDALM	29°12'00"	29°20'43"
	Mafadi	HDALM	29°12'16"	29°21'39"
	Makheka	Lesotho	29°13'54"	29°17'17"
	Ubutsoane (Ubotsoane)	Lesotho	29°12'41"	29°15'46"
Blockfields	Amatola(e) Mountains	Eastern Cape		
	East Griqualand	Kwa-Zulu Natal		
	Eastern Cape Drakensberg	Eastern Cape		
	Eastern Lesotho	Lesotho		
	GGHNP	Free State	28°34'05"	28°35'23"
	HDALM	HDALM		
	Mafadi	HDALM	29°12'16"	29°21'39"
	Matroosberg	Western Cape	33°22'46"	19°40'19"
	Pretoria	Gauteng	25°49'05"	28°18'00"
	Western Cape Mts.	Western Cape		
	Witberge	HDALM		
Blockstreams	Ben MacDhui	Eastern Cape	30°38'44"	27°56'32"
	Butha-Buthe	Lesotho	28°46'01"	28°14'59"
	Estcourt	Kwa-Zulu Natal	29°00'00"	29°52'44"
	Groot Winterberg	Western Cape		
	Letseng-la-Draai (Letseng-la-Terae)	Lesotho	28°53'15"	28°49'32"
	Matroosberg	Western Cape	33°22'46"	19°40'19"
	Mokhotlong	Lesotho	29°17'44"	29°04'38"
	Ox Bow	Lesotho	28°45'57"	28°39'32"
Boulder beds	Bannerman's Pass	HDALM	29°15'25"	29°25'12"
	Nhlangeni	HDALM	29°29'15"	29°18'54"
	Ntabamnyama	HDALM	29°10'26"	29°28'07"
Channel systems	HDALM	HDALM		
Cirque glaciers	Bain's Kloof Pass	Western Cape	33°35'35"	19°07'54"
	Du Toit's Kloof Pass	Western Cape	33°44'30"	19°09'04"
	Hex River Mountains	Western Cape		
	Matroosberg	Western Cape	33°22'46"	19°40'19"
	Western Cape Mts..	Western Cape		
Cirques	Bain's Kloof Pass	Western Cape	33°35'35"	19°07'54"
	Ben Nevis	Old Transkei	30°23'11"	29°29'32"
	Danger's Hoek	Eastern Cape	30°35'27"	27°44'23"
	Du Toit's Kloof Pass	Western Cape	33°44'30"	19°09'04"
	Giant's Castle	HDALM	29°21'00"	29°28'55"
	Giant's Cup (Hodgon's Peak)	HDALM	29°37'05"	29°18'08"
	Hex River Mountains	Western Cape		
	HDALM	HDALM		
	Kubutsane	Lesotho	29°52'38"	29°07'10"
	Matroosberg	Western Cape	33°22'46"	19°40'19"
	Mkomazi (Umkomaas)	HDALM	29°28'30"	29°19'47"
	Mount Currie	Old Transkei	30°28'22"	29°25'16"

Phenomenon	Location	Province/District/ Region	Latitude (S)	Longitude (E)
Cirques	Mount Fifty	Eastern Cape	30°25'20"	29°23'17"
	Sani Pass	HDALM	29°35'35"	29°18'08"
	Thaba Ntsho (Thabana Ntsho or Nts'o)	HDALM	29°50'59"	29°09'06"
	Western Cape Mts.	Western Cape		
	Zwartberg	HDALM	30°07'19"	29°25'47"
Clasts	Tlaeeng Pass	Lesotho	28°54'03"	28°48'28"
Compacted soils	Naude's Pass	Eastern Cape	30°43'35"	28°07'30"
	Sani Pass	HDALM	29°35'35"	29°18'08"
Contraction	Tlaeeng Pass	Lesotho	28°54'03"	28°48'28"
Cryogenic processes	HDALM	HDALM		
	Sani Top	Lesotho	29°35'03'	29°17'02"
	Tlaeeng Pass	Lesotho	28°54'03"	28°48'28"
Cryoplanation terraces	Groot Winterberg	Western Cape		
Cryoturbation	Dynevor Park	Eastern Cape	31°08'44"	27°47'05"
	Matroosberg	Western Cape	33°22'46"	19°40'19"
Cryoturbation features	Dynevor Park	Eastern Cape	31°08'44"	27°47'05"
	Matroosberg	Western Cape	33°22'46"	19°40'19"
	Matroosberg	Western Cape	33°22'46"	19°40'19"
Cutbacks	Bannerman's Pass	HDALM	29°15'25"	29°25'12"
	HDALM	HDALM		
	Ka-Langalilabele	HDALM	29°17'03"	29°26'15"
	Kwa Ntuba	HDALM	29°31'05"	29°17'58"
	Mashai	Lesotho	29°44'11"	29°09'07"
	Mbundini	HDALM	28°50'31"	28°56'46"
	Mkomazi (Umkomaas)	HDALM	29°28'30"	29°19'47"
	Mzimude	HDALM	29°47'27"	29°14'49"
	Nhlangeni	HDALM	29°29'15"	29°18'54"
	Sani Pass	HDALM	29°35'35"	29°18'08"
	Ship's Prow	HDALM	29°05'45"	29°20'01"
	The Judge	HDALM	29°13'22"	29°24'35"
Debris deposit	Bottelnekspruit	Eastern Cape	31°06'00"	27°36'10"
Debris fans	Glen Orchy	Eastern Cape	31°15'16"	27°51'51"
Debris flow	Carlisle's Hoek	Eastern Cape	30°44'27"	27°58'45"
	HDALM	HDALM		
	Rhodes	Eastern Cape	30°47'27"	27°58'06"
Debris mantles	Western Cape Mts.	Western Cape		
Debris ridges	Bottelnekspruit	Eastern Cape	31°06'00"	27°36'10"
	Chesney Wold	Eastern Cape	31°06'30"	27°49'00"
	Kwa Ntuba	HDALM	29°31'05"	29°17'58"
	Nhlangeni	HDALM	29°29'15"	29°18'54"
	Ship's Prow	HDALM	29°05'45"	29°20'01"
Desiccation polygon	Tlaeeng Pass	Lesotho	28°54'03"	28°48'28"
Dislocation (of stones)	Matroosberg	Western Cape	33°22'46"	19°40'19"
Emplacement	GGHNP	Free State	28°34'05"	28°35'23"
Erosion	Giant's Cup (Hudson's Peak)	HDALM	29°37'05"	29°18'08"
Erosional hollows	Berlin	Free State	28°30'12"	28°30'14"
	Blanca (E)	Free State	28°33'59"	28°18'42"
	Braamhof	Free State	28°33'44"	28°21'11"
	Butha-Buthe	Lesotho	28°46'01"	28°14'59"
	Dunblane (S)	Free State	28°32'38"	28°24'19"
	East Griqualand	Kwa-Zulu Natal		
	Eastern Cape Drakensberg	Eastern Cape		
	Eastern Lesotho	Lesotho		
	Estcourt	Kwa-Zulu Natal	29°00'00"	29°52'44"
	Giant's Cup (Hudson's Peak)	HDALM	29°37'05"	29°18'08"
	GGHNP	Free State	28°34'05"	28°35'23"
	Groenhoek	Free State	28°26'57"	28°37'15"
	HDALM	HDALM		

Phenomenon	Location	Province/District/ Region	Latitude (S)	Longitude (E)
Erosional hollows	Ingeli (Ngeli)	HDALM	30°37'59"	29°37'19"
	Insizwa (Ntsizwa)	HDALM	30°47'11"	29°12'19"
	Koeberg	Free State	28°29'59"	28°32'25"
	Letseng-la-Draai (Letseng-la-Terae)	Lesotho	28°53'15"	28°49'32"
	Matroosberg	Western Cape	33°22'46"	19°40'19"
	Melsetter	Free State	28°30'37"	28°41'17"
	Mokhotlong	Lesotho	29°17'44"	29°04'38"
	Mont-aux-Sources	Lesotho	28°46'22"	28°52'16"
	Mount Currie	Old Transkei	30°28'22"	29°25'16"
	Mount Horeb	Free State	28°30'20"	28°27'54"
	Ox Bow	Lesotho	28°45'57"	28°39'32"
	Rhodes	Eastern Cape	30°47'27"	27°58'06"
	Sani Pass	HDALM	29°35'35"	29°18'08"
	Seqouqou	Lesotho	29°31'46"	29°09'07"
	Spes Bona	Free State	28°32'10"	28°28'59"
	Sunnyside (E)	Free State	28°32'14"	28°31'48"
	Sunnyside (W)	Free State	28°32'14"	28°31'48"
	Thabana Ntleyana	Lesotho	29°28'11"	29°16'06"
	Tlaeeng Pass	Lesotho	28°54'03"	28°48'28"
	Wilgenhof	Free State	28°29'44"	28°35'08"
	Witberge	HDALM		
	Wodehouse	Free State	28°32'14"	28°38'39"
Flarks	Khalong-la-Lithunya (Pass of Guns)	Lesotho	28°49'11"	28°47'14"
Fluvial	Dynevor Park	Eastern Cape	31°08'44"	27°47'05"
	Glen Orchy	Eastern Cape	31°15'16"	27°51'51"
	HDALM	HDALM		
Fluvio-glacial	Bannerman's Pass	HDALM	29°15'25"	29°25'12"
	Bell River valley	Eastern Cape	30°49'38"	27°50'13"
	Carlisle's Hoek	Eastern Cape	30°44'27"	27°58'45"
	HDALM	HDALM		
	Kwa Ntuba	HDALM	29°31'05"	29°17'58"
	Nhlangeni	HDALM	29°29'15"	29°18'54"
	Rifle Spruit	Eastern Cape	30°51'49"	27°57'15"
	Ship's Prow	HDALM	29°05'45"	29°20'01"
	Western Cape	Western Cape Mts.		
Fluvio-glacial deposits	Kwa Ntuba	HDALM	29°31'05"	29°17'58"
	Nhlangeni	HDALM	29°29'15"	29°18'54"
	Rifle Spruit	Eastern Cape	30°51'49"	27°57'15"
	Ship's Prow	HDALM	29°05'45"	29°20'01"
	Western Cape Mts.	Western Cape		
Freeze-thaw	East Griqualand	Kwa-Zulu Natal		
	Eastern Cape Drakensberg	Eastern Cape		
	Eastern Lesotho	Lesotho		
	Giant's Cup (Hudson's Peak)	HDALM	29°37'05"	29°18'08"
	HDALM	HDALM		
	Injasuthi (Njesuthi)	HDALM	29°12'00"	29°20'43"
	Mafadi	HDALM	29°12'16"	29°21'39"
	Makheka	Lesotho	29°13'54"	29°17'17"
	Mokhotlong	Lesotho	29°17'44"	29°04'38"
	Naude's Pass	Eastern Cape	30°43'35"	28°07'30"
	Sani Pass	HDALM	29°35'35"	29°18'08"
	Thabana Ntleyana	Lesotho	29°28'11"	29°16'06"
	Tlaeeng Pass	Lesotho	28°54'03"	28°48'28"
	Ubutsoane (Ubotsoane)	Lesotho	29°12'41"	29°15'46"
	Witberge	HDALM		
Freezing	Mount Superior	Western Cape	33°30'49"	19°20'39"
Frost action	Ben MacDhui	Eastern Cape	30°38'44"	27°56'32"
	Bottelnekspruit	Eastern Cape	31°06'00"	27°36'10"
	Butha-Buthe	Lesotho	28°46'01"	28°14'59"
	Carlisle's Hoek	Eastern Cape	30°44'27"	27°58'45"
	Eastern Cape Drakensberg	Eastern Cape		

Phenomenon	Location	Province/District/ Region	Latitude (S)	Longitude (E)
Frost action	Estcourt	Kwa-Zulu Natal	29°00'00"	29°52'44"
	GGHNP	Free State	28°34'05"	28°35'23"
	HDALM	HDALM		
	Letseng-la-Draai (Letseng-la-Terae)	Lesotho	28°53'15"	28°49'32"
	Matroosberg	Western Cape	33°22'46"	19°40'19"
	Mohlesi Valley	HDALM	29°28'54"	29°18'08"
	Mokhotlong	Lesotho	29°17'44"	29°04'38"
	Mont-aux-Sources	Lesotho	28°46'22"	28°52'16"
	Naude's Pass	Eastern Cape	30°43'35"	28°07'30"
	Old Transkei	HDALM		
	Ox Bow	Lesotho	28°45'57"	28°39'32"
	Rhodes	Eastern Cape	30°47'27"	27°58'06"
	Sani Pass	HDALM	29°35'35"	29°18'08"
	Seqouqou	Lesotho	29°31'46"	29°09'07"
	Thabana Ntleyana	Lesotho	29°28'11"	29°16'06"
Frost climate	Bain's Kloof	Western Cape	33°35'35"	19°07'54"
	Du Toit's Kloof	Western Cape	33°44'30"	19°09'04"
	Hex River Mountains	Western Cape		
	Matroosberg	Western Cape	33°22'46"	19°40'19"
Frost creep	Champagne Castle	Kwa-Zulu Natal	29°05'35"	29°19'55"
	Dynevor Park	Eastern Cape	31°08'44"	27°47'05"
	HDALM	HDALM		
	Little Berg	HDALM		
	Mount Superior	Western Cape	33°30'49"	19°20'39"
	Mount Superior	Western Cape	33°30'49"	19°20'39"
	Nkosazana Cave	HDALM	29°04'19"	29°19'08"
	Nkosazana Valley	HDALM	29°04'14"	29°18'04"
	Tlaeeng Pass	Lesotho	28°54'03"	28°48'28"
Frost heave	Butha-Buthe	Lesotho	28°46'01"	28°14'59"
	Champagne Castle	Kwa-Zulu Natal	29°05'35"	29°19'55"
	Eastern Cape Drakensberg	Eastern Cape		
	Hex River Mountains	Western Cape		
	HDALM	HDALM		
	Letseng-la-Draai (Letseng-la-Terae)	Lesotho	28°53'15"	28°49'32"
	Mafadi	HDALM	29°12'16"	29°21'39"
	Matroosberg	Western Cape	33°22'46"	19°40'19"
	Mont-aux-Sources	Lesotho	28°46'22"	28°52'16"
	Mount Superior	Western Cape	33°30'49"	19°20'39"
	Naude's Pass	Eastern Cape	30°43'35"	28°07'30"
	Nkosazana Cave	HDALM	29°04'19"	29°19'08"
	Nkosazana Valley	HDALM	29°04'14"	29°18'04"
	Ox Bow	Lesotho	28°45'57"	28°39'32"
	Sani Pass	HDALM	29°35'35"	29°18'08"
	Seqouqou	Lesotho	29°31'46"	29°09'07"
	Thabana Ntleyana	Lesotho	29°28'11"	29°16'06"
	Tlaeeng Pass	Lesotho	28°54'03"	28°48'28"
Frost shattering	Bottelnekspruit	Eastern Cape	31°06'00"	27°36'10"
	Chesney Wold	Eastern Cape	31°06'30"	27°49'00"
	GGHNP	Free State	28°34'05"	28°35'23"
	Groot Winterberg	Western Cape		
	HDALM	HDALM		
	Rose Hill	Eastern Cape	31°06'50"	27°36'00"
	Tlaeeng Pass	Lesotho	28°54'03"	28°48'28"
	Western Cape Mts.	Western Cape		
Frost sorting	HDALM	HDALM		
Frost wedging	HDALM	HDALM		
	Injasuthi (Njesuthi)	HDALM	29°12'00"	29°20'43"
	Kazani (Kozani)	Lesotho	29°38'47"	29°24'41"
	Letseng-la-Draai (Letseng-la-Terae)	Lesotho	28°53'15"	28°49'32"
	Mafadi	HDALM	29°12'16"	29°21'39"
	Makheka	Lesotho	29°13'54"	29°17'17"

Phenomenon	Location	Province/District/ Region	Latitude (S)	Longitude (E)
Frost wedging	Matroosberg	Western Cape	33°22'46"	19°40'19"
	Thabana Ntleyana	Lesotho	29°28'11"	29°16'06"
	Ubutsoane (Ubotsoane)	Lesotho	29°12'41"	29°15'46"
Frozen ground	Dynevor Park	Eastern Cape	31°08'44"	27°47'05"
	Gray's Pass	HDALM	29°04'14"	29°19'36"
	HDALM	HDALM		
	Mount Superior	Western Cape	33°30'49"	19°20'39"
	Naude's Pass	Eastern Cape	30°43'35"	28°07'30"
	Stellenbosch Mountains	Western Cape	33°57'03"	18°51'31"
Geliflual action	Breede River Mountains	Western Cape		
	Camp's Bay	Western Cape	33°57'00"	18°22'40"
	Drakenstein Mountains	Western Cape		
	Du Toit's Kloof Pass	Western Cape	33°44'30"	19°09'04"
	Giant's Castle	HDALM	29°21'00"	29°28'55"
	Giant's Castle	HDALM	29°21'00"	29°28'55"
	Grahamstown/Port Alfred	Western Cape	33°21'49"	26°31'57"
	Gydo Pass	Western Cape	33°14'11"	19°20'00"
	Gydo Pass	Western Cape	33°14'11"	19°20'00"
	Llandudno	Western Cape	34°00'25"	18°20'31"
	Magaliesburg	Northwest Province	25°59'00"	273216
	Magaliesburg	Northwest Province	25°59'00"	273216
	Pretoria	Gauteng	25°49'05"	28°18'00"
	Stellenbosch Mountains	Western Cape	33°57'03"	18°51'31"
Geliflual apron	Breede River Mountains	Western Cape		
	Camp's Bay	Western Cape	33°57'00"	18°22'40"
	Drakenstein Mountains	Western Cape		
	Du Toit's Kloof Pass	Western Cape	33°44'30"	19°09'04"
	Grahamstown/Port Alfred	Western Cape	33°21'49"	26°31'57"
	Llandudno	Western Cape	34°00'25"	18°20'31"
	Stellenbosch Mountains	Western Cape	33°57'03"	18°51'31"
	Breede River Mountains	Western Cape		
	Camp's Bay	Western Cape	33°57'00"	18°22'40"
	Drakenstein Mountains	Western Cape		
	Du Toit's Kloof Pass	Western Cape	33°44'30"	19°09'04"
	Llandudno	Western Cape	34°00'25"	18°20'31"
	Stellenbosch Mountains	Western Cape	33°57'03"	18°51'31"
Geliflual deposits	Giant's Castle	HDALM	29°21'00"	29°28'55"
	Grahamstown/Port Alfred	Western Cape	33°21'49"	26°31'57"
	Gydo Pass	Western Cape	33°14'11"	19°20'00"
Gelifluction	Ben MacDhui	Eastern Cape	30°38'44"	27°56'32"
	Breede River Mountains	Western Cape		
	Camp's Bay	Western Cape	33°57'00"	18°22'40"
	Champagne Castle	Kwa-Zulu Natal	29°05'35"	29°19'55"
	Drakenstein Mountains	Western Cape		
	Du Toit's Kloof Pass	Western Cape	33°44'30"	19°09'04"
	Dynevor Park	Eastern Cape	31°08'44"	27°47'05"
	Eastern Cape Drakensberg	Eastern Cape		
	GGHNP	Free State	28°34'05"	28°35'23"
	Grahamstown/Port Alfred	Western Cape	33°21'49"	26°31'57"
	HDALM	HDALM		
	Llandudno	Western Cape	34°00'25"	18°20'31"
	Nkosazana Cave	HDALM	29°04'19"	29°19'08"
	Nkosazana Valley	HDALM	29°04'14"	29°18'04"
	Pretoria	Gauteng	25°49'05"	28°18'00"
	Stellenbosch Mountains	Western Cape	33°57'03"	18°51'31"
	Tiffendell Ski Resort	Eastern Cape	30°40'22"	27°56'53"
	Tlaeeng Pass	Lesotho	28°54'03"	28°48'28"
	Western Cape Mts.	Western Cape		
Gelifluction (head) deposits	Berlin	Free State	28°30'12"	28°30'14"
	Blanca (E)	Free State	28°33'59"	28°18'42"
	Braamhof	Free State	28°33'44"	28°21'11"

Phenomenon	Location	Province/District/ Region	Latitude (S)	Longitude (E)
Gelifluction (head) deposits	Dunblane (S)	Free State	28°32'38"	28°24'19"
	Groenhoek	Free State	28°26'57"	28°37'15"
	Koeberg	Free State	28°29'59"	28°32'25"
	Melsetter	Free State	28°30'37"	28°41'17"
	Mount Horeb	Free State	28°30'20"	28°27'54"
	Spes Bona	Free State	28°32'10"	28°28'59"
	Sunnyside (E)	Free State	28°32'14"	28°31'48"
	Sunnyside (W)	Free State	28°32'14"	28°31'48"
	Wilgenhof	Free State	28°29'44"	28°35'08"
	Wodehouse	Free State	28°32'14"	28°38'39"
Gelifluction deposits	Dynevor Park	Eastern Cape	31°08'44"	27°47'05"
	Eastern Cape Drakensberg	Eastern Cape		
	GGHNP	Free State	28°34'05"	28°35'23"
	HDALM	HDALM		
	Western Cape Mts.	Western Cape		
Gelifluction head deposit	Bell River valley	Eastern Cape	30°49'38"	27°50'13"
	Berlin	Free State	28°30'12"	28°30'14"
	Blanca (E)	Free State	28°33'59"	28°18'42"
	Braamhof	Free State	28°33'44"	28°21'11"
	Dunblane (S)	Free State	28°32'38"	28°24'19"
	Groenhoek	Free State	28°26'57"	28°37'15"
	Koeberg	Free State	28°29'59"	28°32'25"
	Melsetter	Free State	28°30'37"	28°41'17"
	Mount Horeb	Free State	28°30'20"	28°27'54"
	Spes Bona	Free State	28°32'10"	28°28'59"
	Sunnyside (E)	Free State	28°32'14"	28°31'48"
	Sunnyside (W)	Free State	28°32'14"	28°31'48"
	Wilgenhof	Free State	28°29'44"	28°35'08"
	Wodehouse	Free State	28°32'14"	28°38'39"
Gelifluction sheets	HDALM	HDALM		
Gelisolifluction	Groot Winterberg	Western Cape		
	Matroosberg	Western Cape	33°22'46"	19°40'19"
Glacial	Birnam	Eastern Cape	30°54'16"	27°51'15"
	Chesney Wold	Eastern Cape	31°06'30"	27°49'00"
	HDALM	HDALM		
	Rose Hill	Eastern Cape	31°06'50"	27°36'00"
	Western Cape Mts.	Western Cape		
Glacial deposits	Western Cape Mts.	Western Cape		
Glacial erosion	Bain's Kloof Pass	Western Cape	33°35'35"	19°07'54"
	Barkly Pass	Eastern Cape	31°14'11"	27°51'29"
	Bell River valley	Eastern Cape	30°49'38"	27°50'13"
	Bokspruit valley	Eastern Cape	30°52'22"	27°52'06"
	Bottelnekspruit	Eastern Cape	31°06'00"	27°36'10"
	Danger's Hoek	Eastern Cape	30°35'27"	27°44'23"
	Du Toit's Kloof Pass	Western Cape	33°44'30"	19°09'04"
	Franschoek Valley	Western Cape	33°59'05"	19°07'01"
	Hex River Mountains	Western Cape		
	HDALM	HDALM		
	Injasuthi (Njesuthi)	HDALM	29°12'00"	29°20'43"
	Jonkershoek Valley	Western Cape	33°58'25"	18°54'53"
	Knockwarren Farm	Eastern Cape	30°55'38"	27°54'45"
	Mafadi	HDALM	29°12'16"	29°21'39"
	Makheka	Lesotho	29°13'54"	29°17'17"
	Matroosberg	Western Cape	33°22'46"	19°40'19"
	Rhodes	Eastern Cape	30°47'27"	27°58'06"
	Rifle Spruit	Eastern Cape	30°51'49"	27°57'15"
	Stettyn's Kloof	Western Cape		
	Thabana Ntleyana	Lesotho	29°28'11"	29°16'06"
	Ubutsoane (Ubotsoane)	Lesotho	29°12'41"	29°15'46"
Glacial pavements	Western Cape Mts.	Western Cape		
Glacial polish	HDALM	HDALM		

Phenomenon	Location	Province/District/ Region	Latitude (S)	Longitude (E)
Glacial polish	Injasuthi (Njesuthi)	HDALM	29°12'00"	29°20'43"
	Jonkershoek Valley	Western Cape	33°58'25"	18°54'53"
	Mafadi	HDALM	29°12'16"	29°21'39"
	Makheka	Lesotho	29°13'54"	29°17'17"
	Matroosberg	Western Cape	33°22'46"	19°40'19"
	Stettyn's Kloof	Western Cape		
	Thabana Ntleyana	Lesotho	29°28'11"	29°16'06"
	Ubutsoane (Ubotsoane)	Lesotho	29°12'41"	29°15'46"
	Western Cape Mts.	Western Cape		
Glacial striations	Barkly Pass	Eastern Cape	31°14'11"	27°51'29"
	Bell River valley	Eastern Cape	30°49'38"	27°50'13"
	Bokspruit valley	Eastern Cape	30°52'22"	27°52'06"
	Matroosberg	Western Cape	33°22'46"	19°40'19"
	Rhodes	Eastern Cape	30°47'27"	27°58'06"
	Western Cape Mts.	Western Cape		
Glaciation	Kwa Ntuba	HDALM	29°31'05"	29°17'58"
	Nhlangeni	HDALM	29°29'15"	29°18'54"
	Ship's Prow	HDALM	29°05'45"	29°20'01"
Gravel sorting	Butha-Buthe	Lesotho	28°46'01"	28°14'59"
	Letseng-la-Draai (Letseng-la-Terae)	Lesotho	28°53'15"	28°49'32"
	Mont-aux-Sources	Lesotho	28°46'22"	28°52'16"
	Sani Pass	HDALM	29°35'35"	29°18'08"
	Seqouqou	Lesotho	29°31'46"	29°09'07"
	Thabana Ntleyana	Lesotho	29°28'11"	29°16'06"
Grèzes litées	Dynevor Park	Eastern Cape	31°08'44"	27°47'05"
	Rhodes	Eastern Cape	30°47'27"	27°58'06"
Ground ice	Tlaeeng Pass	Lesotho	28°54'03"	28°48'28"
Hanging valleys	Danger's Hoek	Eastern Cape	30°35'27"	27°44'23"
Hogsbacks	Matroosberg	Western Cape	33°22'46"	19°40'19"
Ice-shattered ridges	Garden Castle	HDALM	29°45'57"	29°16'24"
	Ntabamnyama	HDALM	29°10'26"	29°28'07"
Ice-stripped areas	Bamboo Mountain	HDALM	29°44'35"	29°21'56"
	Garden Castle	HDALM	29°45'57"	29°16'24"
	Giant's Cup (Hodgon's Peak)	HDALM	29°37'05"	29°18'08"
	Kazani (Kozani)	Lesotho	29°38'47"	29°24'41"
	Mkomazi (Umkomaas)	HDALM	29°28'30"	29°19'47"
	Sani Pass	HDALM	29°35'35"	29°18'08"
	Stromness	HDALM	29°42'43"	29°33'43"
	Thaba Ntsho (Thabana Ntsho or Nts'o)	HDALM	29°50'59"	29°09'06"
Ice-wedge casts	Dynevor Park	Eastern Cape	31°08'44"	27°47'05"
	Rhodes	Eastern Cape	30°47'27"	27°58'06"
Ice-wedges	Injasuthi (Njesuthi)	HDALM	29°12'00"	29°20'43"
	Mafadi	HDALM	29°12'16"	29°21'39"
	Makheka	Lesotho	29°13'54"	29°17'17"
	Rhodes	Eastern Cape	30°47'27"	27°58'06"
	Thabana Ntleyana	Lesotho	29°28'11"	29°16'06"
	Ubutsoane (Ubotsoane)	Lesotho	29°12'41"	29°15'46"
Inversion of weathering profile	Magaliesburg	Northwest Province	25°59'00"	27°32'16"
Kame moraine	Carlisle's Hoek	Eastern Cape	30°44'27"	27°58'45"
Kame-terrace	Bell River valley	Eastern Cape	30°49'38"	27°50'13"
Lacustrine deposits	Birnam	Eastern Cape	30°54'16"	27°51'15"
Mass movement	Amatola(e) Mountains	Eastern Cape		
	Butha-Buthe	Lesotho	28°46'01"	28°14'59"
	GGHNP	Free State	28°34'05"	28°35'23"
	HDALM	HDALM		
	Letseng-la-Draai (Letseng-la-Terae)	Lesotho	28°53'15"	28°49'32"
	Mont-aux-Sources	Lesotho	28°46'22"	28°52'16"
	Sani Pass	HDALM	29°35'35"	29°18'08"
	Seqouqou	Lesotho	29°31'46"	29°09'07"
	Thabana Ntleyana	Lesotho	29°28'11"	29°16'06"

Phenomenon	Location	Province/District/ Region	Latitude (S)	Longitude (E)
Mass movement	Western Cape Mts.	Western Cape		
Moraines	Bain's Kloof Pass	Western Cape	33°35'35"	19°07'54"
	Du Toit's Kloof Pass	Western Cape	33°44'30"	19°09'04"
	Franschoek Valley	Western Cape	33°59'05"	19°07'01"
	Hex River Mountains	Western Cape		
	HDALM	HDALM		
	Knockwarren Farm	Eastern Cape	30°55'38"	27°54'45"
	Matroosberg	Western Cape	33°22'46"	19°40'19"
	Western Cape Mts.	Western Cape		
Needle ice	Butha-Buthe	Lesotho	28°46'01"	28°14'59"
	Eastern Cape Drakensberg	Eastern Cape		
	Estcourt	Kwa-Zulu Natal	29°00'00"	29°52'44"
	GGHNP	Free State	28°34'05"	28°35'23"
	HDALM	HDALM		
	HDALM	Mike's Pass	28°57'33"	29°13'46"
	Letseng-la-Draai (Letseng-la-Terae)	Lesotho	28°53'15"	28°49'32"
	Little Berg	HDALM		
	Mafadi	HDALM	29°12'16"	29°21'39"
	Mokhotlong	Lesotho	29°17'44"	29°04'38"
	Mont-aux-Sources	Lesotho	28°46'22"	28°52'16"
	Mpumalanga	Long Tom Pass	25°09'00"	30°36'00"
	Old Transkei	HDALM		
	Ox Bow	Lesotho	28°45'57"	28°39'32"
	Tlaeeng Pass	Lesotho	28°54'03"	28°48'28"
	Western Cape Mts.	Western Cape		
Nets	Butha-Buthe	Lesotho	28°46'01"	28°14'59"
	Estcourt	Kwa-Zulu Natal	29°00'00"	29°52'44"
	Letseng-la-Draai (Letseng-la-Terae)	Lesotho	28°53'15"	28°49'32"
	Little Berg	HDALM		
	Mokhotlong	Lesotho	29°17'44"	29°04'38"
	Ox Bow	Lesotho	28°45'57"	28°39'32"
Niche (hollow)	Bannerman's Pass	HDALM	29°15'25"	29°25'12"
	HDALM	HDALM		
	Kwa Ntuba	HDALM	29°31'05"	29°17'58"
	Nhlangeni	HDALM	29°29'15"	29°18'54"
	Ship's Prow	HDALM	29°05'45"	29°20'01"
Niche glacier	HDALM	HDALM		
Nivation	Bamboo Mountain	HDALM	29°44'35"	29°21'56"
	Ben Nevis	Old Transkei	30°23'11"	29°29'32"
	Berlin	Free State	28°30'12"	28°30'14"
	Blanca (E)	Free State	28°33'59"	28°18'42"
	Bokspruit valley	Eastern Cape	30°52'22"	27°52'06"
	Bottelnekspruit	Eastern Cape	31°06'00"	27°36'10"
	Braamhof	Free State	28°33'44"	28°21'11"
	Bushmansnek	HDALM	29°52'22"	29°08'08"
	Dunblane (S)	Free State	28°32'38"	28°24'19"
	Elandsberg	Eastern Cape	32°30'00"	26°53'14"
	Gaika's Kop	Eastern Cape	32°32'44"	26°57'15"
	Garden Castle	HDALM	29°45'57"	29°16'24"
	Giant's Cup (Hodgon's Peak)	HDALM	29°37'05"	29°18'08"
	GGHNP	Free State	28°34'05"	28°35'23"
	Groenhoek	Free State	28°26'57"	28°37'15"
	Hangklip	HDALM	29°54'46"	29°11'26"
	HDALM	HDALM		
	Ingeli (Ngeli)	HDALM	30°37'59"	29°37'19"
	Ingugu (Ngqungqu)	HDALM	30°22'22"	29°32'32"
	Kazani (Kozani)	Lesotho	29°38'47"	29°24'41"
	Koeberg	Free State	28°29'59"	28°32'25"
	Kokstad	Kwa-Zulu Natal	30°32'44"	29°25'16"
	Kubutsane	Lesotho	29°52'38"	29°07'10"
	Matroosberg	Western Cape	33°22'46"	19°40'19"

Phenomenon	Location	Province/District/ Region	Latitude (S)	Longitude (E)
Nivation	Melsetter	Free State	28°30'37"	28°41'17"
	Mkomazi (Umkomaas)	HDALM	29°28'30"	29°19'47"
	Mount Currie	Old Transkei	30°28'22"	29°25'16"
	Mount Emma	Old Transkei	30°26'44"	29°35'41"
	Mount Enterprise	Eastern Cape	31°09'04"	27°59'57"
	Mount Fifty	Eastern Cape	30°25'20"	29°23'17"
	Mount Horeb	Free State	28°30'20"	28°27'54"
	Nolangeni	HDALM	30°38'15"	29°26'15"
	Ntabamnyama	HDALM	29°10'26"	29°28'07"
	Rhodes	Eastern Cape	30°47'27"	27°58'06"
	Rockford Ridge	Eastern Cape	32°09'00"	27°16'00"
	Sani Pass	HDALM	29°35'35"	29°18'08"
	Spes Bona	Free State	28°32'10"	28°28'59"
	Spitzkop	Old Transkei	30°17'44"	29°31'42"
	Stromness	HDALM	29°42'43"	29°33'43"
	Sunnyside (E)	Free State	28°32'14"	28°31'48"
	Sunnyside (W)	Free State	28°32'14"	28°31'48"
	Tafelberg	Eastern Cape	32°07'46"	26°30'57"
	Thaba Ntsho (Thabana Ntsho or Nts'o)	HDALM	29°50'59"	29°09'06"
	Wilgenhof	Free State	28°29'44"	28°35'08"
	Wodehouse	Free State	28°32'14"	28°38'39"
	Zwartberg	HDALM	30°07'19"	29°25'47"
Nivation niches	GGHNP	Free State	28°34'05"	28°35'23"
	HDALM	HDALM		
Nonsorted circles	Butha-Buthe	Lesotho	28°46'01"	28°14'59"
	Estcourt	Kwa-Zulu Natal	29°00'00"	29°52'44"
	Injasuthi (Njesuthi)	HDALM	29°12'00"	29°20'43"
	Letseng-la-Draai (Letseng-la-Terae)	Lesotho	28°53'15"	28°49'32"
	Little Berg	HDALM		
	Mafadi	HDALM	29°12'16"	29°21'39"
	Makheka	Lesotho	29°13'54"	29°17'17"
	Matroosberg	Western Cape	33°22'46"	19°40'19"
	Mokhotlong	Lesotho	29°17'44"	29°04'38"
	Ox Bow	Lesotho	28°45'57"	28°39'32"
	Thabana Ntleyana	Lesotho	29°28'11"	29°16'06"
	Ubutsoane (Ubotsoane)	Lesotho	29°12'41"	29°15'46"
Nonsorted polygon	Ben MacDhui	Eastern Cape	30°38'44"	27°56'32"
	Butha-Buthe	Lesotho	28°46'01"	28°14'59"
	Injasuthi (Njesuthi)	HDALM	29°12'00"	29°20'43"
	Letseng-la-Draai (Letseng-la-Terae)	Lesotho	28°53'15"	28°49'32"
	Mafadi	HDALM	29°12'16"	29°21'39"
	Makheka	Lesotho	29°13'54"	29°17'17"
	Mont-aux-Sources	Lesotho	28°46'22"	28°52'16"
	Sani Pass	HDALM	29°35'35"	29°18'08"
	Seqouqou	Lesotho	29°31'46"	29°09'07"
	Thabana Ntleyana	Lesotho	29°28'11"	29°16'06"
	Ubutsoane (Ubotsoane)	Lesotho	29°12'41"	29°15'46"
Nonsorted stripes	Tlaeeng Pass	Lesotho	28°54'03"	28°48'28"
Palaeosol	Bell River valley	Eastern Cape	30°49'38"	27°50'13"
	Bottelnekspruit	Eastern Cape	31°06'00"	27°36'10"
	Glen Orchy	Eastern Cape	31°15'16"	27°51'51"
	HDALM	HDALM		
	Rhodes	Eastern Cape	30°47'27"	27°58'06"
	Tlaeeng Pass	Lesotho	28°54'03"	28°48'28"
Patterned ground	Butha-Buthe	Lesotho	28°46'01"	28°14'59"
	Letseng-la-Draai (Letseng-la-Terae)	Lesotho	28°53'15"	28°49'32"
	Mont-aux-Sources	Lesotho	28°46'22"	28°52'16"
	Sani Pass	HDALM	29°35'35"	29°18'08"
	Seqouqou	Lesotho	29°31'46"	29°09'07"
	Thabana Ntleyana	Lesotho	29°28'11"	29°16'06"
Pebbels	Western Cape Mts.	Western Cape		

Phenomenon	Location	Province/District/ Region	Latitude (S)	Longitude (E)
Periglacial processes	Butha-Buthe	Lesotho	28°46'01"	28°14'59"
	East Griqualand	Kwa-Zulu Natal		
	GGHNP	Free State	28°34'05"	28°35'23"
	Groot Winterberg	Western Cape		
	HDALM	HDALM		
	Ingeli (Ngeli)	HDALM	30°37'59"	29°37'19"
	Insizwa (Ntsizwa)	HDALM	30°47'11"	29°12'19"
	Letseng-la-Draai (Letseng-la-Terae)	Lesotho	28°53'15"	28°49'32"
	Maluti Range	HDALM		
	Matroosberg	Western Cape	33°22'46"	19°40'19"
	Mont-aux-Sources	Lesotho	28°46'22"	28°52'16"
	Mount Currie	Old Transkei	30°28'22"	29°25'16"
	Rhodes	Eastern Cape	30°47'27"	27°58'06"
	Sani Pass	HDALM	29°35'35"	29°18'08"
	Seqouqou	Lesotho	29°31'46"	29°09'07"
	Thabana Ntleyana	Lesotho	29°28'11"	29°16'06"
	Tlaeeng Pass	Lesotho	28°54'03"	28°48'28"
Periglacial slope-wash	Rhodes	Eastern Cape	30°47'27"	27°58'06"
Permafrost layers	Mokhotlong	Lesotho	29°17'44"	29°04'38"
	Naude's Pass	Eastern Cape	30°43'35"	28°07'30"
	Sani Pass	HDALM	29°35'35"	29°18'08"
Permafrost processes	Bottelnekspruit	Eastern Cape	31°06'00"	27°36'10"
	Naude's Pass	Eastern Cape	30°43'35"	28°07'30"
	Rhodes	Eastern Cape	30°47'27"	27°58'06"
Pinnacles	Matroosberg	Western Cape	33°22'46"	19°40'19"
Planation surfaces	Western Cape Mts.	Western Cape		
Plateau glaciers	Western Cape Mts.	Western Cape		
Polygons	Ben MacDhui	Eastern Cape	30°38'44"	27°56'32"
	Butha-Buthe	Lesotho	28°46'01"	28°14'59"
	Eastern Cape Drakensberg	Eastern Cape		
	Hex River Mountains	Western Cape		
	HDALM	HDALM		
	Injasuthi (Njesuthi)	HDALM	29°12'00"	29°20'43"
	Letseng-la-Draai (Letseng-la-Terae)	Lesotho	28°53'15"	28°49'32"
	Little Berg	HDALM		
	Mafadi	HDALM	29°12'16"	29°21'39"
	Makheka	Lesotho	29°13'54"	29°17'17"
	Matroosberg	Western Cape	33°22'46"	19°40'19"
	Mont-aux-Sources	Lesotho	28°46'22"	28°52'16"
	Mount Superior	Western Cape	33°30'49"	19°20'39"
	Ox Bow	Lesotho	28°45'57"	28°39'32"
	Sani Pass	HDALM	29°35'35"	29°18'08"
	Sehlabathebe National Park	HDALM	28°54'11"	29°03'54"
	Seqouqou	Lesotho	29°31'46"	29°09'07"
	Thabana Ntleyana	Lesotho	29°28'11"	29°16'06"
	Tlaeeng Pass	Lesotho	28°54'03"	28°48'28"
	Ubutsoane (Ubotsoane)	Lesotho	29°12'41"	29°15'46"
Potholes	Western Cape Mts.	Western Cape		
Protalus ramparts	Berlin	Free State	28°30'12"	28°30'14"
	Blanca (E)	Free State	28°33'59"	28°18'42"
	Bokspruit valley	Eastern Cape	30°52'22"	27°52'06"
	Braamhof	Free State	28°33'44"	28°21'11"
	Dunblane (S)	Free State	28°32'38"	28°24'19"
	GGHNP	Free State	28°34'05"	28°35'23"
	Groenhoek	Free State	28°26'57"	28°37'15"
	Koeberg	Free State	28°29'59"	28°32'25"
	Melsetter	Free State	28°30'37"	28°41'17"
	Mount Enterprise	Eastern Cape	31°09'04"	27°59'57"
	Mount Horeb	Free State	28°30'20"	28°27'54"
	Spes Bona	Free State	28°32'10"	28°28'59"
	Sunnyside (E)	Free State	28°32'14"	28°31'48"

Phenomenon	Location	Province/District/ Region	Latitude (S)	Longitude (E)
Protalus ramparts	Sunnyside (W)	Free State	28°32'14"	28°31'48"
	Wilgenhof	Free State	28°29'44"	28°35'08"
	Wodehouse	Free State	28°32'14"	28°38'39"
River terraces	Cathedral Cave valley	Kwa-Zulu Natal	29°01'30"	29°15'00"
	Glen Orchy	Eastern Cape	31°15'16"	27°51'51"
	Ribbok Valley	Free State	28°32'22"	28°36'19"
Rockglaciers	Bokspruit valley	Eastern Cape	30°52'22"	27°52'06"
	Bottelnekspruit	Eastern Cape	31°06'00"	27°36'10"
	Chesney Wold	Eastern Cape	31°06'30"	27°49'00"
	Rose Hill	Eastern Cape	31°06'50"	27°36'00"
Screes	Amatola(e) Mountains	Eastern Cape		
	Bokspruit valley	Eastern Cape	30°52'22"	27°52'06"
	Elandsberg	Eastern Cape	32°30'00"	26°53'14"
	Gaika's Kop	Eastern Cape	32°32'44"	26°57'15"
	GGHNP	Free State	28°34'05"	28°35'23"
	Hogsback	Eastern Cape	32°37'05"	27°00'00"
	Kazani (Kozani)	Lesotho	29°38'47"	29°24'41"
	Rockford Ridge	Eastern Cape	32°09'00"	27°16'00"
	Tafelberg	Eastern Cape	32°07'46"	26°30'57"
Sedimentary sequences	Bottelnekspruit	Eastern Cape	31°06'00"	27°36'10"
	Carlisle's Hoek	Eastern Cape	30°44'27"	27°58'45"
	Rhodes	Eastern Cape	30°47'27"	27°58'06"
	Sani Top	Lesotho	29°35'03"	29°17'02"
	Tlaeeng Pass	Lesotho	28°54'03"	28°48'28"
Segregation ice	HDALM	HDALM		
	Mafadi	HDALM	29°12'16"	29°21'39"
Sheet-wash	Cathedral Peak Forestry Research St.	Kwa-Zulu Natal	28°55'05"	29°06'48"
	Dynevor Park	Eastern Cape	31°08'44"	27°47'05"
Slip scars	Injasuthi (Njesuthi)	HDALM	29°12'00"	29°20'43"
	Mafadi	HDALM	29°12'16"	29°21'39"
	Makheka	Lesotho	29°13'54"	29°17'17"
	Thabana Ntleyana	Lesotho	29°28'11"	29°16'06"
	Ubutsoane (Ubotsoane)	Lesotho	29°12'41"	29°15'46"
Snow patch conditions	Bamboo Mountain	HDALM	29°44'35"	29°21'56"
	Ben Nevis	Old Transkei	30°23'11"	29°29'32"
	Berlin	Free State	28°30'12"	28°30'14"
	Blanca (E)	Free State	28°33'59"	28°18'42"
	Bokspruit valley	Eastern Cape	30°52'22"	27°52'06"
	Braamhof	Free State	28°33'44"	28°21'11"
	Bushmansnek	HDALM	29°52'22"	29°08'08"
	Dunblane (S)	Free State	28°32'38"	28°24'19"
	Garden Castle	HDALM	29°45'57"	29°16'24"
	Giant's Castle	HDALM	29°21'00"	29°28'55"
	Giant's Cup (Hodgon's Peak)	HDALM	29°37'05"	29°18'08"
	GGHNP	Free State	28°34'05"	28°35'23"
	Groenhoek	Free State	28°26'57"	28°37'15"
	Hangklip	HDALM	29°54'46"	29°11'26"
	HDALM	HDALM		
	Ingeli (Ngeli)	HDALM	30°37'59"	29°37'19"
	Ingugu (Ngqungqu)	HDALM	30°22'22"	29°32'32"
	Kazani (Kozani)	Lesotho	29°38'47"	29°24'41"
	Koeberg	Free State	28°29'59"	28°32'25"
	Kokstad	Kwa-Zulu Natal	30°32'44"	29°25'16"
	Kubutsane	Lesotho	29°52'38"	29°07'10"
	Melsetter	Free State	28°30'37"	28°41'17"
	Mkomazi (Umkomaas)	HDALM	29°28'30"	29°19'47"
	Mount Currie	Old Transkei	30°28'22"	29°25'16"
	Mount Emma	Old Transkei	30°26'44"	29°35'41"
	Mount Fifty	Eastern Cape	30°25'20"	29°23'17"
	Mount Horeb	Free State	28°30'20"	28°27'54"

Phenomenon	Location	Province/District/ Region	Latitude (S)	Longitude (E)
Snow patch conditions	Nolangeni	HDALM	30°38'15"	29°26'15"
	Ntabamnyama	HDALM	29°10'26"	29°28'07"
	Sani Pass	HDALM	29°35'35"	29°18'08"
	Spes Bona	Free State	28°32'10"	28°28'59"
	Spitzkop	Old Transkei	30°17'44"	29°31'42"
	Stromness	HDALM	29°42'43"	29°33'43"
	Sunnyside (E)	Free State	28°32'14"	28°31'48"
	Sunnyside (W)	Free State	28°32'14"	28°31'48"
	Thaba Ntsho (Thabana Ntsho or Nts'o)	HDALM	29°50'59"	29°09'06"
	Wilgenhof	Free State	28°29'44"	28°35'08"
	Wodehouse	Free State	28°32'14"	28°38'39"
	Zwartberg	HDALM	30°07'19"	29°25'47"
Snow patch meltwater	GGHNP	Free State	28°34'05"	28°35'23"
	GGHNP	Free State	28°34'05"	28°35'23"
Soil creep	Glen Orchy	Eastern Cape	31°15'16"	27°51'51"
	Little Berg	HDALM		
	Long Tom Pass	Mpumalanga	25°09'00"	30°36'00"
	Matroosberg	Western Cape	33°22'46"	19°40'19"
	Mike's Pass	HDALM	28°57'33"	29°13'46"
	Western Cape Mts.	Western Cape		
Solifluction	Amatola(e) Mountains	Eastern Cape		
	Berlin	Free State	28°30'12"	28°30'14"
	Blanca (E)	Free State	28°33'59"	28°18'42"
	Braamhof	Free State	28°33'44"	28°21'11"
	Brandwag	Free State	28°34'05"	28°34'36"
	Butha-Buthe	Lesotho	28°46'01"	28°14'59"
	Cathedral Cave valley	Kwa-Zulu Natal	29°01'30"	29°15'00"
	Dunblane (S)	Free State	28°32'38"	28°24'19"
	East Griqualand	Kwa-Zulu Natal		
	Eastern Cape Drakensberg	Eastern Cape		
	Eastern Lesotho	Lesotho		
	Estcourt	Kwa-Zulu Natal	29°00'00"	29°52'44"
	Giant's Castle	HDALM	29°21'00"	29°28'55"
	Glen Orchy	Eastern Cape	31°15'16"	27°51'51"
	GGHNP	Free State	28°34'05"	28°35'23"
	Groenhoek	Free State	28°26'57"	28°37'15"
	HDALM	HDALM		
	Koeberg	Free State	28°29'59"	28°32'25"
	Letseng-la-Draai (Letseng-la-Terae)	Lesotho	28°53'15"	28°49'32"
	Little Berg	HDALM		
	Matroosberg	Western Cape	33°22'46"	19°40'19"
	Melsetter	Free State	28°30'37"	28°41'17"
	Mokhotlong	Lesotho	29°17'44"	29°04'38"
	Mont-aux-Sources	Lesotho	28°46'22"	28°52'16"
	Mount Horeb	Free State	28°30'20"	28°27'54"
	Mount Superior	Western Cape	33°30'49"	19°20'39"
	Ntabamnyama	HDALM	29°10'26"	29°28'07"
	Ox Bow	Lesotho	28°45'57"	28°39'32"
	Ribbok Valley	Free State	28°32'22"	28°36'19"
	Sani Pass	HDALM	29°35'35"	29°18'08"
	Seqouqou	Lesotho	29°31'46"	29°09'07"
	Spes Bona	Free State	28°32'10"	28°28'59"
	Sunnyside (E)	Free State	28°32'14"	28°31'48"
	Sunnyside (W)	Free State	28°32'14"	28°31'48"
	Thabana Ntleyana	Lesotho	29°28'11"	29°16'06"
	Western Cape Mts.	Western Cape		
	Wilgenhof	Free State	28°29'44"	28°35'08"
	Witberge	HDALM		
	Wodehouse	Free State	28°32'14"	28°38'39"
Solifluction deposits	Bushmansnek	HDALM	29°52'22"	29°08'08"

Phenomenon	Location	Province/District/ Region	Latitude (S)	Longitude (E)
Solifluction deposits	East Griqualand	Kwa-Zulu Natal		
	Eastern Cape Drakensberg	Eastern Cape		
	Eastern Lesotho	Lesotho		
	Garden Castle	HDALM	29°45'57"	29°16'24"
	Giant's Cup (Hodgon's Peak)	HDALM	29°37'05"	29°18'08"
	Glen Orchy	Eastern Cape	31°15'16"	27°51'51"
	Hangklip	HDALM	29°54'46"	29°11'26"
	Kazani (Kozani)	Lesotho	29°38'47"	29°24'41"
	Mkomazi (Umkomaas)	HDALM	29°28'30"	29°19'47"
	Mount Currie	Old Transkei	30°28'22"	29°25'16"
	Mount Fifty	Eastern Cape	30°25'20"	29°23'17"
	Ntabamnyama	HDALM	29°10'26"	29°28'07"
	Sani Pass	HDALM	29°35'35"	29°18'08"
	Stromness	HDALM	29°42'43"	29°33'43"
	Witberge	HDALM		
Solifluction lobes	Amatola(e) Mountains	Eastern Cape		
	GGHNP	Free State	28°34'05"	28°35'23"
Solifluction sheet	Butha-Buthe	Lesotho	28°46'01"	28°14'59"
	Letseng-la-Draai (Letseng-la-Terae)	Lesotho	28°53'15"	28°49'32"
	Mont-aux-Sources	Lesotho	28°46'22"	28°52'16"
	Sani Pass	HDALM	29°35'35"	29°18'08"
	Seqouqou	Lesotho	29°31'46"	29°09'07"
	Thabana Ntleyana	Lesotho	29°28'11"	29°16'06"
Solifluction slump	Bushmansnek	HDALM	29°52'22"	29°08'08"
	East Griqualand	Kwa-Zulu Natal		
	Eastern Cape Drakensberg	Eastern Cape		
	Eastern Lesotho	Lesotho		
	Garden Castle	HDALM	29°45'57"	29°16'24"
	Giant's Cup (Hodgon's Peak)	HDALM	29°37'05"	29°18'08"
	Hangklip	HDALM	29°54'46"	29°11'26"
	Kazani (Kozani)	Lesotho	29°38'47"	29°24'41"
	Mkomazi (Umkomaas)	HDALM	29°28'30"	29°19'47"
	Mount Currie	Old Transkei	30°28'22"	29°25'16"
	Mount Fifty	Eastern Cape	30°25'20"	29°23'17"
	Ntabamnyama	HDALM	29°10'26"	29°28'07"
	Sani Pass	HDALM	29°35'35"	29°18'08"
	Stromness	HDALM	29°42'43"	29°33'43"
	Witberge	HDALM		
Solifluction terraces	Ben MacDhui	Eastern Cape	30°38'44"	27°56'32"
	Brandwag	Free State	28°34'05"	28°34'36"
	Cathedral Cave valley	Kwa-Zulu Natal	29°01'30"	29°15'00"
	HDALM	HDALM		
	Ribbok Valley	Free State	28°32'22"	28°36'19"
	Tiffendell Ski Resort	Eastern Cape	30°40'22"	27°56'53"
Soliflucional smoothing	Butha-Buthe	Lesotho	28°46'01"	28°14'59"
	Estcourt	Kwa-Zulu Natal	29°00'00"	29°52'44"
	GGHNP	Free State	28°34'05"	28°35'23"
	Letseng-la-Draai (Letseng-la-Terae)	Lesotho	28°53'15"	28°49'32"
	Mokhotlong	Lesotho	29°17'44"	29°04'38"
	Mont-aux-Sources	Lesotho	28°46'22"	28°52'16"
	Ox Bow	Lesotho	28°45'57"	28°39'32"
	Sani Pass	HDALM	29°35'35"	29°18'08"
	Seqouqou	Lesotho	29°31'46"	29°09'07"
	Thabana Ntleyana	Lesotho	29°28'11"	29°16'06"
Solution	Long Tom Pass	Mpumalanga	25°09'00"	30°38'00"
	Mike's Pass	HDALM	28°57'33"	29°13'46"
Sorted circles	Gray's Pass	HDALM	29°04'14"	29°19'36"
	HDALM	HDALM		
	Little Berg	HDALM		
	Mount Superior	Western Cape	33°30'49"	19°20'39"
Sorted nets	Butha-Buthe	Lesotho	28°46'01"	28°14'59"

Phenomenon	Location	Province/District/ Region	Latitude (S)	Longitude (E)
Sorted nets	Estcourt	Kwa-Zulu Natal	29°00'00"	29°52'44"
	Letseng-la-Draai (Letseng-la-Terae)	Lesotho	28°53'15"	28°49'32"
	Little Berg	HDALM		
	Mokhotlong	Lesotho	29°17'44"	29°04'38"
	Ox Bow	Lesotho	28°45'57"	28°39'32"
Sorted polygons	Eastern Cape Drakensberg	Eastern Cape		
	Hex River Mountains	Western Cape		
	HDALM	HDALM		
	Injasuthi (Njesuthi)	HDALM	29°12'00"	29°20'43"
	Little Berg	HDALM		
	Mafadi	HDALM	29°12'16"	29°21'39"
	Makheka	Lesotho	29°13'54"	29°17'17"
	Matroosberg	Western Cape	33°22'46"	19°40'19"
	Mount Superior	Western Cape	33°30'49"	19°20'39"
	Ox Bow	Lesotho	28°45'57"	28°39'32"
	Sehlabathebe National Park	HDALM	28°54'11"	29°03'54"
	Tlaeeng Pass	Lesotho	28°54'03"	28°48'28"
	Ubutsoane (Ubotsoane)	Lesotho	29°12'41"	29°15'46"
Sorted stripes	Eastern Cape Drakensberg	Eastern Cape		
	Hex River Mountains	Western Cape		
	HDALM	HDALM		
	Little Berg	HDALM		
	Mafadi	HDALM	29°12'16"	29°21'39"
	Matroosberg	Western Cape	33°22'46"	19°40'19"
	Mount Superior	Western Cape	33°30'49"	19°20'39"
	Ox Bow	Lesotho	28°45'57"	28°39'32"
Stone-banked terraces	Giant's Castle	HDALM	29°21'00"	29°28'55"
	HDALM	HDALM		
	Mount Superior	Western Cape	33°30'49"	19°20'39"
	Nkosazana Valley	HDALM	29°04'14"	29°18'04"
	Western Cape Mts.	Western Cape		
Stripes	Eastern Cape Drakensberg	Eastern Cape		
	Hex River Mountains	Western Cape		
	HDALM	HDALM		
	Little Berg	HDALM		
	Mafadi	HDALM	29°12'16"	29°21'39"
	Matroosberg	Western Cape	33°22'46"	19°40'19"
	Mount Superior	Western Cape	33°30'49"	19°20'39"
	Ox Bow	Lesotho	28°45'57"	28°39'32"
	Tlaeeng Pass	Lesotho	28°54'03"	28°48'28"
Surface creep	Western Cape Mts.	Western Cape		
Surface runoff	Khalong-la-Lithunya (Pass of Guns)	Lesotho	28°49'11"	28°47'14"
	Little Berg	HDALM		
Terminal moraine	Carlisle's Hoek	Eastern Cape	30°44'27"	27°58'45"
Terracettes	Butha-Buthe	Lesotho	28°46'01"	28°14'59"
	Cathedral Peak Forestry Research St.	Kwa-Zulu Natal	28°55'05"	29°06'48"
	Estcourt	Kwa-Zulu Natal	29°00'00"	29°52'44"
	GGHNP	Free State	28°34'05"	28°35'23"
	Letseng-la-Draai (Letseng-la-Terae)	Lesotho	28°53'15"	28°49'32"
	Little Berg	HDALM		
	Long Tom Pass	Mpumalanga	25°09'00"	30°38'00"
	Mike's Pass	HDALM	28°57'33"	29°13'46"
	Mokhotlong	Lesotho	29°17'44"	29°04'38"
	Mont-aux-Sources	Lesotho	28°46'22"	28°52'16"
	Nkosazana Cave	HDALM	29°04'19"	29°19'08"
	Ox Bow	Lesotho	28°45'57"	28°39'32"
	Sani Pass	HDALM	29°35'35"	29°18'08"
	Seqouqou	Lesotho	29°31'46"	29°09'07"
	Thabana Ntleyana	Lesotho	29°28'11"	29°16'06"
	Tlaeeng Pass	Lesotho	28°54'03"	28°48'28"

Phenomenon	Location	Province/District/ Region	Latitude (S)	Longitude (E)
Terracettes (turf-banked)	Little Berg	HDALM		
Thawing	HDALM	HDALM		
	Sekakes Mission	Lesotho	30°00'00"	28°21'00"
Thufur	Bell River valley	Eastern Cape	30°49'38"	27°50'13"
	Butha-Buthe	Lesotho	28°46'01"	28°14'59"
	Estcourt	Kwa-Zulu Natal	29°00'00"	29°52'44"
	Giant's Cup (Hudson's Peak)	HDALM	29°37'05"	29°18'08"
	HDALM	HDALM		
	Injasuthi (Njesuthi)	HDALM	29°12'00"	29°20'43"
	Letseng-la-Draai (Letseng-la-Terae)	Lesotho	28°53'15"	28°49'32"
	Little Berg	HDALM		
	Mafadi	HDALM	29°12'16"	29°21'39"
	Makheka	Lesotho	29°13'54"	29°17'17"
	Mohlesi Valley	HDALM	29°28'54"	29°18'08"
	Mokhotlong	Lesotho	29°17'44"	29°04'38"
	Mont-aux-Sources	Lesotho	28°46'22"	28°52'16"
	Naude's Pass	Eastern Cape	30°43'35"	28°07'30"
	Ox Bow	Lesotho	28°45'57"	28°39'32"
	Sani Pass	HDALM	29°35'35"	29°18'08"
	Seqouqou	Lesotho	29°31'46"	29°09'07"
	Thabana Ntleyana	Lesotho	29°28'11"	29°16'06"
	Tina Head Farm	Eastern Cape	30°39'33"	28°12'49"
	Tlaeeng Pass	Lesotho	28°54'03"	28°48'28"
	Ubutsoane (Ubotsoane)	Lesotho	29°12'41"	29°15'46"
Tors	Bannerman's Pass	HDALM	29°15'25"	29°25'12"
	Champagne Castle	Kwa-Zulu Natal	29°05'35"	29°19'55"
	East Griqualand	Kwa-Zulu Natal		
	HDALM	HDALM		
	Ingeli (Ngeli)	HDALM	30°37'59"	29°17'39"
	Insizwa (Ntsizwa)	HDALM	30°47'11"	29°12'19"
	Ka-Langalilabele	HDALM	29°17'03"	29°26'15"
	Kwa Ntuba	HDALM	29°31'05"	29°17'58"
	Mashai	Lesotho	29°44'11"	29°09'07"
	Mbundini	HDALM	28°50'31'	28°56'46"
	Mkomazi (Umkomaas)	HDALM	29°28'30"	29°19'47"
	Mount Currie	Old Transkei	30°28'22"	29°25'16"
	Mzimude	HDALM	29°47'27"	29°14'49"
	Nhlangeni	HDALM	29°29'15"	29°18'54"
	Sani Pass	HDALM	29°35'35"	29°18'08"
	Ship's Prow	HDALM	29°05'45"	29°20'01"
	The Judge	HDALM	29°13'22"	29°24'35"
	Danger's Hoek	Eastern Cape	30°35'27"	27°44'23"
Trough-like valleys	Rifle Spruit	Eastern Cape	30°51'49"	27°57'15"
Truncated spurs	Rifle Spruit	Eastern Cape	30°51'49"	27°57'15"
Turf exfoliation	Butha-Buthe	Lesotho	28°46'01"	28°14'59"
	Letseng-la-Draai (Letseng-la-Terae)	Lesotho	28°53'15"	28°49'32"
	Little Berg	HDALM		
	Mont-aux-Sources	Lesotho	28°46'22"	28°52'16"
	Sani Pass	HDALM	29°35'35"	29°18'08"
	Seqouqou	Lesotho	29°31'46"	29°09'07"
	Thabana Ntleyana	Lesotho	29°28'11"	29°16'06"
Turf-banked terraces	Champagne Castle	Kwa-Zulu Natal	29°05'35"	29°19'55"
	Little Berg	HDALM		
	Matroosberg	Western Cape	33°22'46"	19°40'19"
	Mount Superior	Western Cape	33°30'49"	19°20'39"
Valley asymmetry	East Griqualand	Kwa-Zulu Natal		
	Garden Castle	HDALM	29°45'57"	29°16'24"
	GGHNP	Free State	28°34'05"	28°35'23"
	Hangklip	HDALM	29°54'46"	29°11'26"
	HDALM	HDALM		
	Ingeli (Ngeli)	HDALM	30°37'59"	29°37'19"

Phenomenon	Location	Province/District/ Region	Latitude (S)	Longitude (E)
Valley asymmetry	Ingugu (Ngqunggu)	HDALM	30°22'22"	29°32'32"
	Injasuthi (Njesuthi)	HDALM	29°12'00"	29°20'43"
	Insizwa (Ntsizwa)	HDALM	30°47'11"	29°12'19"
	Kokstad	Kwa-Zulu Natal	30°32'44"	29°25'16"
	Mafadi	HDALM	29°12'16"	29°21'39"
	Makheka	Lesotho	29°13'54"	29°17'17"
	Maluti Range	HDALM		
	Mount Currie	Old Transkei	30°28'22"	29°25'16"
	Mount Emma	Old Transkei	30°26'44"	29°35'41"
	Nolangeni	HDALM	30°38'15"	29°26'15"
	Spitzkop	Old Transkei	30°17'44"	29°31'42"
	Thabana Ntleyana	Lesotho	29°28'11"	29°16'06"
	Ubutsoane (Ubotsoane)	Lesotho	29°12'41"	29°15'46"
Valley glaciers	Western Cape Mts.	Western Cape		
Vertical stacking	Butha-Buthe	Lesotho	28°46'01"	28°14'59"
	Letseng-la-Draai (Letseng-la-Terae)	Lesotho	28°53'15"	28°49'32"
	Matroosberg	Western Cape	33°22'46"	19°40'19"
	Mont-aux-Sources	Lesotho	28°46'22"	28°52'16"
	Sani Pass	HDALM	29°35'35"	29°18'08"
	Seqouqou	Lesotho	29°31'46"	29°09'07"
	Thabana Ntleyana	Lesotho	29°28'11"	29°16'06"

Abbreviations

GGHNP	Golden Gate National Park
HDALM	High Drakensberg and Lesotho Mountains
St.	Station
Mts.	Mountains

APPENDIX G

English/Afrikaans Terminology Index

English/Afrikaans Terminology Index

For more geomorphological terminology in Afrikaans, refer to Van der Merwe & De Villiers (1978). *Vir meer Afrikaanse geomorfologiese terme, raadpleeg Van der Merwe & De Villiers (1978).*

Terminology	**Preferred usage**	**Afrikaans**
Amphitheatre-shaped hollow	Hollow	Holte
Ancient soil	Palaeosol	Fossielgrond
Aréte	Aréte	Arête
Avalanche[1]	Avalanche	Lawine
Avalanche deposit	Avalanche deposit	Lawine afsetting
Avalanche front	Avalanche front	Lawine uitloper*
Basalt step	Basalt step	Basaltiese teras*
Biennially frozen ground	Permafrost	Permafrost
Block masses	Boulder bed	Rostbloklaag*
Blockfield	Blockfield	Blokveld
Blockmeer	Blockfield	Blokveld
Blockstream	Blockstream	Blokstroom*
Boulder	Boulder	Rotsblok
Boulder bed	Boulder bed	Rotsbloklaag*
Boulder field	Blockfield	Blokveld
Cattle step	Terracette	Terraset
Channel system	Channel system	Kanaalsisteem
Cirque	Cirque	Trogeinde
Cirque glacier	Cirque glacier	Trogeindeglester
Cirque-like hollow	Erosional hollow	Erosieholte
Clast	Clast	-
Climafrost	Permafrost	Permafrost
Compacted soil	Compacted soil	Gekompakteerde grond
Congelisolifluction	Solifluction	Bodemvloei
Congelifraction	Frost shattering	Ysverwering
Congeliturbation	Cryoturbation	Krioturbasie
Contraction	Contraction	Inkrimping
Corrie	Cirque	Trogeinde
Corrie sheet	Cirque glacier	Trogeindegletser
Cryic layer	Permafrost	Permafrost
Cryogenic process (action)	Cryogenic process (action)	Ys- en sneeuwerking

[1] It is recommended that the term "avalanche" should be specified, e.g. "snow avalanche", "mud avalanche", "stone avalanche" etc., depending on the researcher's findings. *Dit is wenslik om die term "lawine" te kwalifiseer, byv. "sneeulawine", "modderlawine", "rotslawine"ens., afhangende van navorsingsbevindinge. In die meeste gevalle kan die woord "-storting", wat 'n beter Afrikaanse beskrywing is, ook gebruik word, byv. "sneeustorting", "rotsstorting", "modderstorting" ens.*

Terminology	Preferred usage	Afrikaans
Cryoplanation	Cryoplanation	Krioplanasie, vlaktevorming deur ys
Cryoplanation terraces	Cryoplanation terraces	Krioplanasie terrasse
Cryoturbates	Cryoturbation	Krioturbasie
Cryoturbation	Cryoturbation	Krioturbasie
Cryoturbation feature(s)	Cryoturbation feature(s)	Krioturbasie verskynsels
Cutback	Cutback	Terugsnydingsvallei
Cwm	Cirque	Trogeinde
Debris	Debris	Puin
Debris fan	Debris fan	Puinwaaier
Debris flow	Debris flow	Puinvloei*
Debris lobe	Protalus rampart	Protalusstruktuur*
Debris mantle	Debris mantle	Puinoppervlaklaag*
Debris ridge	Debris ridge	Puinrug
Debris tongue	Debris deposit	Puinafsetting
Depressed-centre polygon	Polygon	Poligoon
Desiccation	Desiccation	Uitdroging
Desiccation polygon	Desiccation polygon	Uitdrogingspoligoon*
Diamicton	Diamicton	-
Dislocation (of stones)	Dislocation (of stones)	Verplasing (van klippe)
Downslope sludging (of stones)	Mass movement	Massaverplasing
Earth garland	Turf-banked terrace	Veenterras*
Earth hummock	Earth hummock	Veenbultjie
Earth mound	Earth hummock	Veenbultjie
Embossed rock	Roches moutonnées	Roches moutonnées
Emplacement	Emplacement	Inplasing
Erosion	Erosion	Erosie
Erosional hollow	Erosional hollow	Erosieholte
Esker	Kame moraine	Kamemoreen
Felsenmeer	Blockfield	Blokveld
Fissure polygon	Polygon	Poligoon
Flark	Flark	Moerasagtige gebied
Fluvial	Fluvial	Fluviaal
Fluviatile	Fluvial	Fluviaal
Fluvio-glacial	Fluvio-glacial	Glasio-fluviaal
Fossil ice wedge	Ice-wedge cast	Yswigvorm
Fossil soil	Palaeosol	Fossielgrond
Freeze-thaw weathering	Freeze-thaw weathering	Vries-en-dooiing
Freezing	Freezing	Bevriesing*
Frost action	Frost action	Yswerking
Frost bursting	Frost wedging	Yssplitsing

Terminology	Preferred usage	Afrikaans
Frost churning	Cryoturbation	Krioturbasie
Frost climate	Frost climate	-
Frost cracking	Frost wedging	Yssplitsing
Frost creep	Frost creep	-
Frost heave	Frost heave	Ysopdrukking
Frost mound	Thufur	Veenbultjie, thufur
Frost polygon	Polygon	Poligoon
Frost prying	Frost wedging	Yssplitsing
Frost riving	Frost action, frost wedging	Yswerking, yssplitsing
Frost shattering	Frost shattering	Ysverwering
Frost sorting	Frost sorting	-
Frost splitting	Frost shattering, frost wedging	Ysverwering, yssplitsing
Frost stirring	Cryoturbation	Krioturbasie
Frost thrust	Frost heave	Ysopdrukking
Frost weathering	Frost shattering	Ysverwering
Frost wedging	Frost wedging	Yssplitsing
Frost-crack polygon	Polygon	Poligoon
Frozen ground	Frozen ground	Bevrore grond
Frozen ground phenomenon	Frozen ground phenomenon	Bevrore grond verskynsel
Garland	Stone-banked terrace	Rotsterras*
Garland terrace	Solifluction terrace	Bodemvloeiterras
Geliflual action[2]	Geliflual action	Yssmering
Geliflual apron	Geliflual apron	Yssmeringskort*
Gelifluction	Gelifluction	(Kon)gelifluksie
Gelifluction apron	Gelifluction apron	(Kon)gelifluksieskort
Gelifluction bench	Gelifluction terrace	(Kon)gelifluksieterras
Gelifluction deposit	Gelifluction deposit	(Kon)gelifluksieafsetting
Gelifluction head deposit	Gelifluction head deposit	-
Gelifluction lobe	Gelifluction lobe	(Kon)gelifluksielob
Gelifluction mantle	Gelifluction sheet	(Kon)gelifluksieplaat
Gelifluction sheet	Gelifluction sheet	(Kon)gelifluksieplaat
Gelifluction step	Gelifluction terrace	(Kon)gelifluksieterras
Gelifluction terrace	Gelifluction terrace	(Kon)gelifluksieterras
Gelifraction	Frost action, freeze-thaw weathering	Yswerking, vries-en-ontdooi
Gelisolifluction	Gelisolifluction	-
Geliturbation	Cryoturbation	Krioturbasie
Gendarme	Pinnacle	Toring
Glacial	Glacial	Glasiaal
Glacial erosion	Glacial erosion	Gletser erosie

[2] The term "geliflual" is not recognised by the International Permafrost Association (IPA). *Die term "yssmering" (geliflual) word nie deur die Internasionale Permafrost Vereeniging (IPV) erken nie.*

Terminology	Preferred usage	Afrikaans
Glacial pavement	Glacial pavement	Gletservloer
Glacial phenomenon	Glacial phenomenon	Gletserverskynsel
Glacial polish	Glacial polish	Gletserskuring*
Glacial scratch	Glacial striation	Gletserskraap
Glacial striation	Glacial striation	Gletserskraap
Glaciation	Glaciation	Vergletsering
Glacier	Glacier	Gletser
Glaciofluvial	Fluvio-glacial	Glasio-fluviaal
Grèzes litées	Grèzes litées	Grèzes litées
Ground freeze	Freezing (of the ground)	Bevriesing (van die grond)
Ground ice	Ground ice	Grondys
Hanging valley	Hanging valley	Swewende vallei
Head	Gelifluction head deposit	-
Head deposit	Gelifluction head deposit	-
Hogsback	Hogsback	Isoklinale rug
Hollow	Hollow	Holte
Hummock	Thufur	Veenbultjie, thufur
Ice	Ice	Ys
Ice gneiss	Segregation ice	Gesegregeerde ys
Ice lensing	Ice segregation	Gesegregeerde ys
Ice segregation	Ice segregation	Gesegregeerde ys
Ice shattering	Ice shattering	Ysversplintering
Ice shattered ridge	Ice shattered ridge	Ysversplinteringsrif*
Ice stripping	Ice stripping	Afskuring deur ys*
Ice stripped area	Ice stripped area	Afskuring deur ys*
Ice-wedge	Ice wedge	Yswig
Ice-wedge cast	Ice-wedge cast	Yswigvorm*
Inversion of weathering profile	Inversion of weathering profile	Verweringsinversie*
Kame	Kame	Kame
Kame terrace deposit	Kame terrace deposit	Kameterras (-afsetting)
Kame moraine	Kame moraine	Kamemoreen
Kame terrace	Kame terrace	Kameterras
Lacustral deposit	Lacustrine deposit	Meerafsetting
Lacustrine deposit	Lacustrine deposit	Meerafsetting
Mass flow	Mass movement	Massaverplasing
Mass displacement	Mass movement	Massaverplasing
Mass movement	Mass movement	Massaverplasing
Mass wasting	Mass movement	Massaverplasing
Moraine	Moraine	Moreen
Moraine sheet	Moraine sheet	Moreenplaat
Mud hummock	Earth hummock	Veenbultjie
Mud-debris tongue	Solifluction lobe	Bodemvloeilob

Terminology	Preferred usage	Afrikaans
Needle ice	Needle ice	Naaldys
Needle ice activity	Needle ice activity	Naaldys aktiwiteit, werking
Needle ice stripes	Needle ice activity	Naaldys aktiwiteit, werking
Net	Net	Web*
Niche	Niche hollow	Nisholte*
Niche glacier	Niche glacier	Nisgletser
Nivation cirque	Erosional hollow	Erosieholte
Nivation hollow	Erosional hollow	Erosieholte
Nivation niche	Nivation niche	Sneeuwerkingsnis
Nivation	Nivation	Nivasie, sneeuwerking
Nonsorted circle	Nonsorted circle	Ongesorteerde sirkel
Nonsorted net	Nonsorted net	Ongesorteerde web
Nonsorted polygon	Nonsorted polygon	Ongesorteerde poligoon
Nonsorted step	Nonsorted step	Ongesorteerde trap
Nonsorted stripe	Nonsorted stripe	Ongesorteerde streep
Oversteepened slope	Valley asymmetry	Asimmetriese valley
Palaeosol	Palaeosol	Fossielgrond
Patterned ground	Patterned ground	Struktuurbodem, gemodelleerde grond
Pebble	Pebble	Rolsteen
Perennially cryotic ground	Permafrost	Permafrost
Perennially frozen ground	Permafrost	Permafrost
Periglacial process	Periglacial process	Periglasiale proses
Periglacial slope-wash	Periglacial slope-wash	Periglasiale hangafspoeling
Permafrost	Permafrost	Permafrost
Permafrost layer	Permafrost layer	Permafrostgrondlaag
Permafrost process	Permafrost process	Permafrostproses, permafrostwerking
Permanently frozen ground	Permafrost	Permafrost
Pinnacle	Pinnacle	Toring
Pipkrake	Needle ice	Naaldys
Planation surface	Planation surface	Vlaktevormingsoppervlak
Plateau glacier	Plateau glacier	Plato-gletser
Polygon	Polygon	Poligoon
Pothole	Pothole	Maalgat, slaggat
Protalus rampart	Protalus rampart	Protalusstruktuur*
Pseudomorph	Ice-wedge cast	Yswigvorm*
Raised centre polygon	Polygon	Poligoon
Raked ground	Needle ice activity	Naaldys aktiwiteit
Raked pattern	Needle ice activity	Naaldys aktiwiteit

Terminology	Preferred usage	Afrikaans
Relict soil	Palaeosol	Fossielgrond
River terrace	River terrace	Rivierterras
Roches moutonnées	Roches moutonnées	Roches moutonnées
Rockglacier	Rockglacier	Rotsgletser
Rock river	Blockfield	Blokveld
Rockblock field	Blockfield	Blokveld
Rockstream	Blockfield	Blokveld
Runoff	Surface runoff	Oppervlakafloop
Scree (deposit)	Scree (deposit)	Talusafsetting
Sedimentary sequences	Sedimentary sequences	Sedimentêre opeenvolgings
Segregated ice	Segregation ice	Gesegregeerde ys
Segregation ice	Segregation ice	Gesegregeerde ys
Sheet-flow	Sheet-wash	Oppervlakvloei, laminêre vloei
Sheet-wash	Sheet-wash	Oppervlakvloei, laminêre vloei
Sirloin ice	Segregation ice	Gesegregeerde ys
Slip scar	Slip scar	Hangverskuiwing*
Slope wash	Periglacial slope-wash	Periglaciale hangafspoeling
Slope weathering	Slope weathering	Hangverwering
Slow mass movement	Mass movement	Massaverplasing
Snow patch	Snow patch	Sneeuholte*
Snow patch conditions	Snow patch conditions	Sneeuholte toestande*
Snow patch meltwater	Snow patch meltwater	Sneeusmeltwater
Soil creep	Soil creep	Grondvloeiing, grondkruip
Soil flow	Soil creep	Grondvloeiing, grondkruip
Solifluction	Solifluction	Bodemvloei
Solifluction apron	Solifluction apron	Bodemvloeiskort*
Solifluction bench	Solifluction terrace	Bodemvloeiterras
Solifluction deposit	Solifluction deposit	Bodemvloeiafsetting
Solifluction lobe	Solifluction lobe	Bodemvloeilob*
Solifluction mantle	Solifluction sheet	Bodemvloeiplaat
Solifluction process	Solifluction process	Bodemvloeiproses
Solifluction sheet	Solifluction sheet	Bodemvloeiplaat
Solifluction slump	Solifluction slump	Bodemvloeiversakking*
Solifluction step	Solifluction terrace	Bodemvloeiterras
Solifluction terrace	Solifluction terrace	Bodemvloeiterras
Solifluctional forming	Solifluctional smoothing	-
Solifluctional overforming	Solifluctional smoothing	-
Solifluctional smoothing	Solifluctional smoothing	-
Solifluxion	Solifluction	Bodemvloei
Sorted circle	Sorted circle	Gesorteerde sirkel
Sorted net	Sorted net	Gesorteerde web*

Terminology	Preferred usage	Afrikaans
Sorted polygon	Sorted polygon	Gesorteerde poligoon
Sorted step	Sorted step	Gesorteerde trap
Sorted stripe	Sorted stripe	Gesorteerde streep
Spew-frost (formations)	Cryoturbation feature(s)	Krioturbasie verskynsel(s)
Stone field	Blockfield	Blokveld
Stone garland	Sorted step	Gesorteerde trap
Stone-banked lobe	Stone-banked terrace	Rotsterras*
Stone-banked sheet	Stone-banked terrace	Rotsterras*
Stone-banked step	Stone-banked terrace	Rotsterras*
Stone-banked terrace	Stone-banked terrace	Rotsterras*
Stratified scree	Grézes litèes	Grézes litèes
Stria	Glacial striation	Gletserskraap
Striated soil	Needle ice activity	Naaldys aktiwiteit
Striated solifluction deposit	Grèzes litées	Grèzes litées
Striation	Glacial striation	Gletserskraap
Surface creep	Surface creep	Oppervlakkruip, (oppervlak-) reptasie
Surface runoff	Surface runoff	Oppervlakafloop
Taber ice	Segregation ice	Gesegregeerde ys
Taimyr polygon	Polygon	Poligoon
Talus	Scree (deposit)	Talus
Terminal moraine	Terminal moraine	Trogeindemoreen
Terracette	Terracette	Terraset
Thawing	Thawing	Dooi, ontdooiing
Thufur	Thufur	Veenbultjie, thufur
Tilted and dislocated plates	Vertical stacking	-
Tor	Tor	Tor
Trough's end	Cirque	Trogeinde
Trough valley	Trough valley	Trogvallei
Trough-like valley	Trough-like valley	Trogagtige vallei
Truncated spur	Truncated spur	Afgeknotte bergspoor, afgeknotte uitloper
Tundra hummock	Earth hummock	Veenbultjie
Tundra hummock	Earth hummock, unsorted circle	Veenbultjie, ongesorteerde sirkel
Tundra polygon	Polygon	Poligoon
Turf exfoliation	Turf exfoliation	Veenafskilfering*
Turf hummock	Turf hummock	Turfbultjie
Turf-banked lobe	Turf-banked terrace	Veenterras*
Turf-banked step	Turf-banked terrace	Veenterras*
Turf-banked terrace	Turf-banked terrace	Veenterras*
Turf-banked terracette	Turf-banked terracette	Veenterraset*

Terminology	**Preferred usage**	**Afrikaans**
U-shaped valley	Trough valley	Trogvallei
Valley asymmetry	Valley asymmetry	Asimmetriese vallei
Valley glacier	Valley glacier	Valleigletser
Vertical stacking	Vertical stacking	-

*Own translation.

**Eie vertaling.*