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Engineering Geological Assessment and Rock Mass  
Characterization of the Asmari Formation (Zagros Range)  
as Large Dam Foundation Rocks  
in Southwestern Iran

By

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Submitted in partial fulfillment of the requirement for the degree of Doctor of Philosophy  
(Ph.D.) in Engineering Geology in the Faculty of Natural and Agricultural Sciences,  
University of Pretoria  
Pretoria

2012

*In the Name of God*

I, Mehran Koleini hereby declare that this thesis,

“Engineering Geological Assessment and Rock Mass Characterization of the Asmari Formation (Zagros Range) as Large Dam Foundation Rocks in Southwestern Iran”

which I hereby submit for the degree PhD. (Engineering Geology) at the University of Pretoria, is my own work and has not been submitted by me for a degree at this or any other tertiary institution.

2012

## *Acknowledgements*

The following people were of great help and guidance during this research:

- First, I would like to express my special thanks to my supervisor, Prof. J. L. Van Rooy for offering me the opportunity to carry out my research, for his full support and valuable guidance.
- I particularly thank Prof. A. Bumby as my Co-supervisor for his very useful discussions in this research.
- I am very grateful to Prof. P.G. Eriksson as Head of Department of Geology for his administrative guidances.
- I want to express my gratitude to,  
Dr. M. Hashemi (Dept. of Civil Engineering, University of Isfahan-Iran)  
for his helpful consultations during my research in Iran.
- I would also like to thank  
Eng. Banihashemi as Head of Geotechnical office of Mahab Ghodss Consulting Engineers Company, Ministry of Energy- Iran, who provided me with research facilities at Tehran central office, in addition to my field works in Iran.

**Abstract:**

The Zagros fold-thrust belt results from the continent-continent collision between the Arabian margin and the Eurasian plate following the closure of the Neo-Tethys Ocean during the Tertiary. Despite some ongoing controversies about the timing of the onset of the collision there is little doubt that the main episode of the cover shortening in the Zagros folded belt occurred since about 10 Ma as suggested by the youngest folded strata of the Agha Jari red marls.

Shortening by about 70 km derived from balanced sections across the Zagros folded belt, yields shortening rates of  $7 \text{ km Ma}^{-1}$  consistent with the present-day rates of  $0.7 \text{ cm yr}^{-1}$  based on GPS studies. A major unconformity between the Agha Jari formation and the Bakhtyari conglomerates indicates that cover shortening decreased or ceased 5 Ma ago. During or since the deposition of the Bakhtyari Formation, the Zagros fold belt underwent a regional uplift whose origin still remains enigmatic. The deformation is characterized by periodic folding with axial lengths sometimes greater than 200 km. This fold geometry is outlined by the limestone beds of the Asmari Formation, which is one of the main oil reservoirs in the Zagros.

The Zagros also serves as the main originating headspring of the rivers running into the *Persian Gulf* and *Oman Sea* watersheds. Among all these rivers, the major ones are: *Arvand Rud*, *Gamasb*, *Karun*, *Rajah*, *Zaal* and *Marun* join and form *Jarahi*, *Seymareh*, *Qareh Aqhaj*, *Zohreh*, *Dalaki*, *Mend*, *Shur*, *Minab*, *Mehran* and *Naband*. Therefore, the Zagros region has high potential for dam construction to control surface water for electric energy, water supply for irrigation of agricultural lands and land reclamation.

Among various formations in the Zagros region, the Asmari Formation limestone with relatively exclusive characteristics such as rigidity and morphology is a suitable rock foundation for dams in the Zagros range. It should be considered that the Asmari limestones constitute a series of double plunging, asymmetrical folds with northwest-southeast trend and that the southern flanks are steeper than the north-eastern ones ( $70^\circ$  to  $90^\circ$ , locally reversed). Due to varying inclinations, there are much more curvatures of strata in the southwestern flanks of folded structures, with different characteristics of the rock mass in the two flanks of the anticlines. The anticlines, particularly in the Asmari Formation, contain tension-induced, open fracturing which has introduced significant secondary permeability.

Engineering geological investigations indicate that there is a clear relationship between rock mass characteristics of the Asmari Formation and tectonic activities such as various tilting and curvature rates of strata at folded structures in the Zagros Mountain range.

In this regard it should be considered that the upper and middle units of the Asmari Formation that constituted the main dam foundation rock mass on the northern flanks are influenced by karstification processes which have resulted from aggressive mineral waters. Thus huge karst features and cavities can be observed, where the Gachsaran evaporites stratigraphically overlie Asmari Formation succession limestones. The aggressive mineral waters originating from the Gachsaran Formation play the main role in karstification of the Asmari Formation limestones, whereas the lower Asmari is less influenced by these solutions and karstification processes as it is restricted to where the Karun-3 and Karun-4 dams are situated.

Reassessment of available data and geological investigations during this research, lead to a new proposed configuration of engineering characterization of the rock mass for the Asmari formation limestones in the Zagros Region.

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