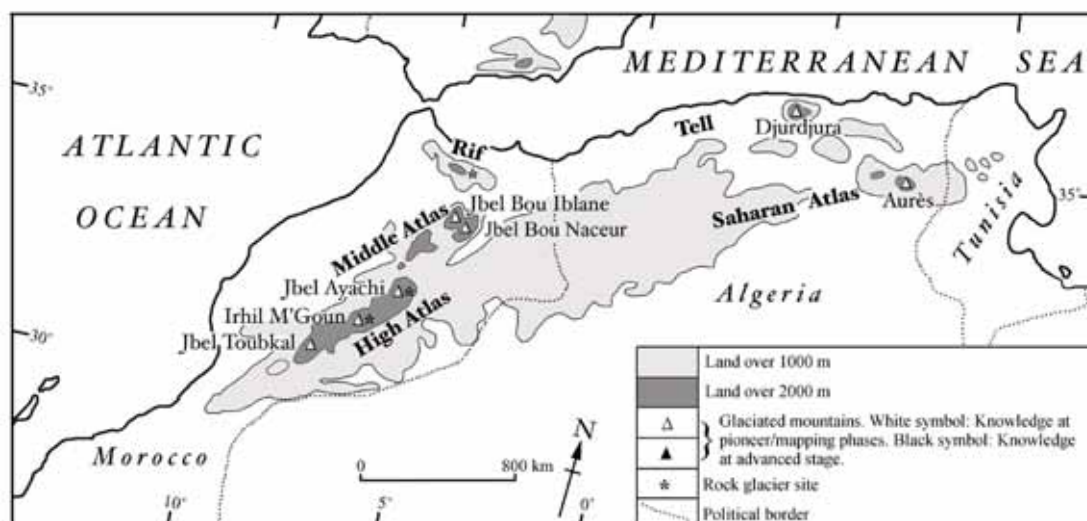


## THE GLACIAL HISTORY OF THE ATLAS MOUNTAINS, MOROCCO

### Background

The mountains surrounding the Mediterranean basin have been glaciated on several occasions through the Quaternary (Hughes *et al.* 2006). The geological and geomorphological record of glaciation in these mountains provides valuable information on past climates, since glaciers are closely related to atmospheric air temperatures and moisture supply. Glaciation in the Mediterranean mountains is particularly important because the mountainous peninsulas of southern Europe, as well as the mountains of North Africa, are thought to have hosted biotic refugia during Pleistocene cold stages. The High Atlas of Morocco are particularly important because of their position at the interface between the North Atlantic Ocean, the western Mediterranean Sea and the Sahara Desert (Figure 1).

**Figure 1.** Location map of the Atlas Mountains, Morocco.



The nature of cold stage climates in the High Atlas is crucial towards understanding the capacity of these areas to support refugial populations of plant and animal species during Pleistocene cold stage local glacier maxima. Moreover, the strategic position of the High Atlas, in close proximity to routes of Palaeolithic Human migration from Africa to Europe highlights the importance of understanding environmental conditions in the neighbouring mountains during Pleistocene cold stages.

Several questions drive this research: 1. What was the distribution, extent and timing of glaciation in the High Atlas during different Pleistocene cold stages? 2. What does the glacial record tell us about former climates during different Pleistocene cold stages? And, 3. What impact would glacial climates have had on wider environmental change in the western Mediterranean?

## **Results**

Glacial deposits are widely preserved down to altitudes as low as 2000 m a.s.l. Extensive field mapping has revealed at least two discrete stratigraphical units: 1) moraines formed by former valley glaciers down to c. 2000 m altitude, and 2) moraines formed by former cirque glaciers at altitudes above 2500 m (Figures 2 & 3). Rock samples were collected from 10 different glacial boulders on the lower and upper moraines for terrestrial cosmogenic nuclide analyses ( $^{10}\text{Be}$ ). Further samples will be collected in 2008 and 2009.

The preliminary fieldwork supported by the QRA Research Fund has led to a successful application for NERC support for cosmogenic isotope analyses (Cosmogenic Isotope Analysis Allocation No. 9038.1007. Samples submitted for processing in May 2008). The preliminary fieldwork supported by the QRA was also crucial in securing the Thesiger-Oman International Fellowship (Royal Geographical Society with IBG) in February 2008.

**Figure 2.** Cirque moraines in the upper Irhzer Iguenouane below Bou Iguenouane (3882 m) in the High Atlas, Morocco. Photograph by Philip Hughes.



**Figure 3.** Arcuate moraine marking the lower limits of a large cirque glacier emanating from the northern cirque (Irhzer Ikhibi Nord) of Tibherine (4010 m) in the High Atlas, Morocco. Photograph by Philip Hughes.



### **References**

Hughes, P.D., Gibbard, P.L. & Woodward, J.C. (2006) Quaternary glacial history of the Mediterranean Mountains. *Progress in Physical Geography* 30, 334–364.

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