

## Experimental study on crustal wehrlites of the Oman ophiolite

STEPHAN SCHOENBORN<sup>1</sup>, JUERGEN KOEPKE<sup>1</sup>,  
SANDRIN T. FEIG<sup>1</sup>, FRANCOISE BOUDIER<sup>2</sup> AND  
ERIC HELLEBRANDT<sup>3</sup>

<sup>1</sup>Institut für Mineralogie, Leibniz Universität Hannover,  
Germany (sschoenborn@web.de)

<sup>2</sup>ISTEEM, University Montpellier, France  
(boudier@dstu.univ-montp2.fr)

<sup>3</sup>SOEST, University of Hawaii, USA (ericwgh@hawaii.edu)

In the Wadi Haymilyah of the Oman ophiolite (Halyn block), discordant wehrlite bodies ranging in size from decameters to hundreds of meters intrude the layered gabbro series at different crustal levels. Common feature of all wehrlite bodies is the dominance of olivine and clinopyroxene with high Mg# ( $\text{MgO}/(\text{MgO}+\text{FeO}) \cdot 100$ , molar) varying between 85 and 95. SIMS analyses of clinopyroxenes from different wehrlite bodies reveal REE and trace element patterns suggesting that the clinopyroxenes were crystallized from tholeiitic, MORB-type melts which were highly depleted in incompatible trace elements. Some wehrlites from the upper section bear mm-sized poikilitic pargasite as magmatic phase, implying that the associated melts showed a high water activity, at least in a late stage. In order to evaluate the genesis of the Oman crustal wehrlites, we combined experimental work with investigations on natural rocks.

The experimental study under controlled  $f\text{O}_2$  and  $a\text{H}_2\text{O}$  at pressure of 200 MPa is aimed to constrain the physical conditions of wehrlitic magmas within the lower oceanic crust. Especially, we want to clarify whether the crustal wehrlites from the Oman ophiolite are derived from wet primitive tholeiitic magmas, as suggested by a model of Feig *et al.* (2006). Starting material are mixtures of natural olivines and clinopyroxene separated from wehrlites from the lower Wadi Haymilyah section, and a synthesized glass representing the "lost" equilibrium melt. Experiments were performed in AuPd capsules (pre-saturated with iron) at temperatures between 1020 and 1160°C with  $f\text{O}_2$  varying between QFM and QFM+2 (QFM=quartz fayalite magnetite buffer). First experiments at nominal dry conditions above 1140°C ( $f\text{O}_2$ : ~ QFM) reveal the stability of plagioclase (newly formed crystals), while the doped clinopyroxene became unstable (decomposition by reaction with the melt). Thus, we were not able to reproduce the characteristic wehrlite paragenesis (olivine plus clinopyroxene without plagioclase) under dry conditions, implying that wehrlitic crystal mushes can not be generated in dry, primitive tholeiitic systems at crustal pressure by simple accumulation of fractionating crystals. The corresponding experiments at wet conditions are in progress.

### References

Feig S.T., Koepke J. and Snow, J., (2006), *Contrib. Mineral. Petrol.* **152**, 611-638.

## Recent developments in U-Pb thermochronology

B. SCHOENE<sup>1,2</sup> AND S.A. BOWRING.<sup>1</sup>

<sup>1</sup>Department of Earth, Atmospheric, and Planetary Sciences,  
Massachusetts Institute of Technology, Cambridge, MA,  
USA (sbowring@mit.edu)

<sup>2</sup>Université de Genève, Section des Sciences de la Terre,  
Geneva, Switzerland (blair.schoene@terre.unige.ch)

Investigations can now be designed to exploit and explore volume diffusion in accessory minerals with the goal of generating accurate temperature-time paths for rocks. Despite the abundance of high-U minerals with high to moderate nominal closure temperatures for the diffusion of Pb (e.g. titanite, apatite, and rutile;  $T_c \sim 400\text{-}650$  °C), U-Pb thermochronology has received little attention compared to lower temperature systems such as  $^{40}\text{Ar}/^{39}\text{Ar}$  and U/Th-He. However, understanding thermal histories of rocks in the 400-650 °C temperature range is crucial for deconvolving the thermal histories of middle and lower crustal rocks.

We have investigated the potential and limitations of U-Pb thermochronology through single- to sub-grain ID-TIMS analysis of apatite and titanite in conjunction with BSE and CL imaging and numerical modeling. The precision of U-Pb thermochronology is usually limited by relatively low ratios of radiogenic lead to initial (a.k.a. common) lead. In systems that have undergone complex rock-fluid interactions, the common practice of using the isotopic composition of Pb in "co-existing" low-U minerals such as feldspar for this correction may be inaccurate. This is especially important in slowly-cooled rocks where the common Pb composition due to fluid interaction may change in time and/or space.

In minerals where volume diffusion controls the distribution of daughter product in a mineral, one expects intra-grain diffusion gradients such that the smallest grains and the rims of large grains record the youngest dates. We have explored relationships between grain size and date (here called *a-t* curves) in apatite and titanite in combination with numerical diffusion modeling. Given some geologic constraints, utilizing *a-t* curves in two minerals from the same rock will allow, in some cases, the generation of unique and non-linear temperature-time paths regardless of the effects of post-cooling reheating from magmatic intrusions.

Numerical modeling can also be used to evaluate the effect of differences in U zonation, cooling rate, and grain shape on closure temperature and *a-t* curves. In many cases these minerals do not form *a-t* curves. This is likely because U-Pb thermochronometers are often involved in metamorphic reactions at a range of temperatures, and therefore characterizing the internal zonation, trace element patterns, and petrographic setting of these minerals may be crucial for generating accurate thermal histories of rocks. This work in conjunction with studies exploiting the U/Th-He method will become more useful in characterizing the behavior of U and its daughter products in high-U thermochronometers and determining thermal histories of rocks from lower-crustal to near surface conditions.