He diffusion on apatite viewed by microbeam ERDA and RBS experiments

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The perfect knowledge of the helium diffusion behavior in minerals is a key issue to interpreted thermochronological (U-Th)/He ages. Indeed, He age is the interplay between alpha particle accumulation produced during radioactive decay in a crystal and its diffusional loss by thermally activated diffusion. In apatite, recoil damage accumulation during α-decay is function of their production via the effective U content and their annealing [1,2,3], which depends on the temperature and grain chemistry.

The recoil damaging has been recognized has as playinging an important role in helium diffusion but its annealing rate combined with the grain chemistry need to be explored. For this purpose, dedicated experiments are conducted by using microbeam ERDA (Elastic Recoil detection analysis) coupled to RBS (Rutherford Backscattering (Spectroscopy) analysis on macro apatite crystals of different compositions. He atoms have been implanted ion polished crystal at 15 keV, (mean projected range of 120 nm) deep and fluences of 10^{17} to 10^{16} He/cm^{2}beam intensity., and Tthe He front is plumbed with in the ERDA experiments using a 15°-15° angle after implantation and different annealing temperature heating steps. RBS and ERDA experiments are conducted on the same grain to characterize the possible effect of natural damage, induced irradiation damages and amorphization for the irradiation higher fluencedose.

ERDA and RBS analyses have been validated for apatite by Ouchani *et al* [4], giving us the possibility to extend diffusion studies toward low temperatures which are hardly attained in experiments based on in-vacuum release. In addition, the irradiation effect on the crystal surface is investigated by AFM to characterize possible high damage zones and possible amorphization. Preliminary ERDA results confirm the influence of damage and the grain chemistry on He diffusion.

[1] Gautheron et al (2009) *Chem. Geol.* **266**, 166-170. [2] Shuster & Farley (2009) *Geochim. Cosmochim. Acta* **73**, 183-196. [3] Gautheron et al (2013) Basin Research, 10.1111/bre.12012. [4] Ouchani et al (1998) *Applied Geochemistry Geochem* **13** (6), 707-714.

Hydrothermal exploration of mid-ocean ridges: Where might the largest sulfide deposits occur?

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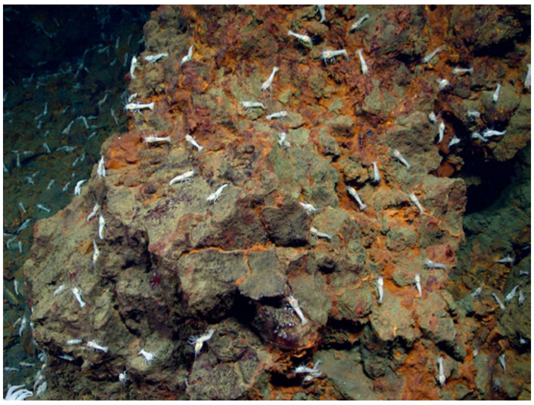
Hydrothermal activity occurs along all mid-ocean ridges, and in all ocean basins. In this paper I will review what is currently known about worldwide distributions of active venting and how that knowledge has evolved since the first discovery of submarine hydrothermal activity in the late 1970s. I will pay partcular attention to the case of slow spreading ridges and discuss the extent to which the incidence of high-temperature venting along such ridges might appear anomalously high when compared to the available magmatic heat budget and whether this may be attribuatble to a difference in the partitioning of hydrothermal heat fluxes between focussed and diffuse flow, at fast- and slow-spreading ridges. Developing this theme, I will discuss the importance of tectonically-hosted hydrothermal fields on slow spreading ridges as locales at which high-temperature fluid flow and associated polymetallic sulfide deposition can be sustained over thousand year time-scales – significantly longer than the perceived decadal lifetimes of vent-sites along fast-spreading ridges. Finally, I will close with a consideration of ultra-slow spreading ridges where venting is also now known to be widespread but where very few active vent-sites have yet been tracked to source. Surprisingly, on these ultra-slow spreading ridges, our preliminary evidence reveals that even neovolcanically hosted hydrothermal fields can apparently be sustained at any one site over sufficiently long time-scales that large polymetallic sulfide deposits can become established.



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