Monazite solubility in high-pressure aqueous melts

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Sediment melting in subduction zone environments is considered to play a key role in the generation of the arc magmatic signature. However, little is known about the details on how particular trace elements (LREE+Th) are effectively transferred from slab to crust. Recent experimental studies have raised the question of whether LREE+Th transport via aqueous melts/siliceous fluids may be limited by low solubilities of accessory phases such as allanite or monazite [e.g. 1,2]. In addition, melting experiments on suitable sediment compositions are rather rare and melt productivity in most studies were low unless carried out at untypically high subduction zone temperatures.

We have carried out an experimental study on hydrous melting of radiolarian clay from the Lesser Antilles, doped with trace elements, at 3 GPa and fO_2 ~ NNO. Melting starts at around 750°C due to the breakdown of phengite + clinopyroxene + coesite, and melt co-exits with mostly garnet + kyanite ± coesite up to around 1250°C. Monazite was identified as LREE+Th buffering phase in some run products.

Most remarkable in our experiments is the very high degrees of melting at relatively low temperatures (e.g. ~25% at 800°C and ~6wt% H_2O present in the experiment, ~50% at 800°C and ~15wt% H_2O, respectively). In addition, initial trace element data indicate a ~10 times higher LREE(La-Sm)+Th solubility at 800°C, and ~3.5 times at 900°C, compared to experiments of e.g. [1] on subducted basaltic crust.

Our experiments suggest that a) water fluxing from underlying sections of the subducted slab may trigger substantial melting at low temperatures, typical for subduction zone environments and b) monazite solubility is strongly dependent on melt chemistry and can be quite high in broadly granitic melts. Results highlight the role of at least some sediment chemistries as viable source for the arc magmatic signature.

[1] Klimm *et al*. (2008), *J. of Petrol.* **49** 523-553. [2] Hermann (2002), *Chem. Geol.* **192** 289-306

Internal surfaces of North Sea chalk imaged and probed with AFM/AFS

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The North Sea chalk is an oil bearing formation of great economic importance but with low yield because large amounts of oil are trapped in very small pore spaces. The chalk is composed of biogenic calcite, mainly algae- produced coccoliths and fragments of these. Most published work assumes that the chalk surface behaves as pristine calcite, but the preservation of the microcrystalline coccoliths for more than 60 mio. years, suggests that something, organic or inorganic, is protecting them from recrystallisation. We think that this protective layer also affects oil retention.

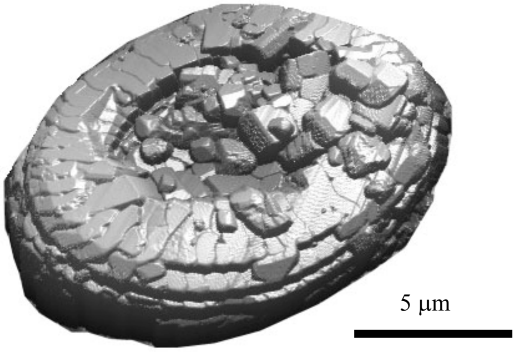

Figure 1. AFM image of a single coccolith.

The sub-nanometer resolution of the atomic force microscope (AFM) is essential for imaging surface structures, and is also crucial for atomic force spectroscopy (AFS). In this technique, the tip is pushed into the surface until the cantilever bends slightly and then it is retracted. The force responsible for the bending is on the order of pico- to nanoNewtons. This allows precise quantification of variations in the physical nature of the surface, such as elasticity and adhesion. By functionalising the tip with organic molecules, we can even probe the chemical nature of the surface. Transmission electron microscopy (TEM) provides additional data about the elementary composition of chalk particles.

The surface of the chalk is heterogeneous on a very small scale and behaves differently than pure calcite. Our results are important for the understanding of wettability.