

The influence of basement fluid upwelling and diagenetic reactions on mineral stabilities in oceanic ridge flank sediments

MONNIN C.¹, WHEAT C. G.² AND MOTTI M.M.³

¹ L.M.T.G./C.N.R.S., 38 rue des Trente-Six Ponts, 31400 Toulouse, France (monnin@lmtg.ups-tlse.fr)

² Global Undersea Research Unit, University of Alaska, P. O. Box 475, Moss Landing, CA 95039, USA

³ Department of Oceanography, University of Hawaii at Manoa, 1000 Pope Road, Honolulu, HI 96822, USA

Heat fluxes measured in oceanic ridge flanks are lower than those calculated assuming conductive cooling of the oceanic crust. A simple explanation assumes that fluxes of cold seawater circulating in the upper part of the crust are large enough to account for the efficient extraction of heat. Data collected during ODP Leg 168 on the Eastern flank of the Juan de Fuca ridge (NE Pacific) suggest that cold seawater penetrates the seafloor through fractures near the ridge axis, and flows eastward in a permeable layer of the uppermost basalts. The thick sedimentary cover acts as a thermal blanket and prevents basement fluids from discharging to the deep ocean. Fluid discharge to the deep ocean has been found to occur either as focused flow in springs such as those found atop a basaltic mound called Baby Bare, located about 100km east of the ridge axis, or as diffuse seepage through thin sediment layers at basement bathymetric highs, such as ODP Sites 1030 and 1031.

Several outcrops, subcrops, and seamounts detected on the Eastern Flank of the Juan de Fuca ridge during previous seismic surveys have been mapped using heat flow measurements and coring during the Retroflux cruise (September 2000). Sediment porewater compositions revealed that most of these areas are locations of basement fluid discharge to the deep ocean. Fluid upwelling through the sediment cover is detected by heat flow anomalies and by changes in porewater compositions compared to that of bottom seawater. Basement fluids have lower sulfate and Mg contents and alkalinities, and higher calcium concentration than normal seawater, as a result of seawater reaction with basalts. Porewater alkalinity profiles are the result of alkalinity production by organic matter oxidation, consumption by calcium carbonate precipitation and eventual advection of an alkalinity deprived basement fluid.

We will present several examples of this competition between diffusion, advection and chemical reactions in cores taken during cruises on the Juan de Fuca and the Costa Rica ridge flanks. We also show, using saturation index calculations, how the saturation state of the sediment porewaters with respect to common marine minerals, like calcium carbonates and barite, changes with the rate of advection of basement fluids.

An experimental study of the dissolution stoichiometry and rates of a natural monazite as a function of temperature from 5 to 50° C and pH from 1 to 12.3

PIERRE MONTAGNAC, STEPHAN J. KÖHLER, FABIEN DUFAUD, AND ÉRIC H. OELKERS

Géochimie, LMTG-UMR CNRS n°5563, Observatoire Midi-Pyrénées - Université Paul-Sabatier 38, rue des 36-Ponts 31400 Toulouse, FRANCE

This goal of this study is the improved understanding of monazite alteration in near surface conditions. The behaviour of monazite, (REE, Th)₂PO₄, during natural water-rock processes is of increasing interest for several distinct reasons including its use as a U-Th-Pb geochronometer and as a possible containment media for high-level nuclear waste.

Steady state dissolution rates of monazite were determined in closed system reactors at 5, 25, and 50°C and 1 < pH < 12.3. All dissolution rates are calculated from release rates of Ce into solution as measured by Inductively Coupled Plasma - Mass Spectrometry. Preliminary pH=2 monazite dissolution rates increase from 3x10⁻¹⁸ mol/cm²/s to 7x10⁻¹⁸ mol/cm²/s with increasing temperature from 25 to 50° C, which is broadly consistent with rates generated at higher temperatures by Oelkers and Poitrasson (2002). Monazite dissolution rates exhibit a typical pH dependence; decrease with increasing pH at acidic conditions, reach a minimum at near neutral pH, and increase with increasing pH at basic conditions. 25° C preliminary dissolution rates were found to be 3x10⁻¹⁸, >5x10⁻²⁰, and 4x10⁻¹⁸ mol/cm²/s at pH=2, 4.8, and 12, respectively.

The light rare earth elements (La, Ce, Pr, and Nd) were found to be released in approximately stoichiometric quantities in all experiments. In contrast, thorium release stoichiometry depended on pH and temperature. Th was released at close to stoichiometric proportions at basic conditions, but was released to solution in far lower proportions at pH 2, likely due to the precipitation of a Th rich secondary phase.

Reference

Oelkers, E.H. and Poitrasson, F. (2002) An experimental study of the dissolution stoichiometry and rates of a natural monazite as a function of temperature from 50 to 230° C and pH from 1.5 to 10. *Chem. Geol.* (in press).