K-Si-metasomatism of 3.4-3.3 Ga volcanoclastic sediments: Implications for Archean seawater evolution

VIRGILE ROUCHON AND BEATE ORBERGER

Université Paris Sud, CNRS UMR-IDES 8148, Département des Sciences de la Terre, Bât. 504/509, 91405 Orsay Cedex, France (virgile.rouchon@u-psud.fr)

The effects of K-Si-metasomatism during the formation of Early Archean replacement cherts were quantified for two examples, the Msauli chert (MC, Barberton greenstone belt, South Africa) and the Kittys Gap chert (KGC, Pilbara craton, Western Australia). The precursor composition of the KGC is similar to dacites of the Duffer formation (Pilbara craton), while the MC have an Al-depleted komatiites precursor, similar to those from the Weltevreden Formation (Barberton greenstone belt). Based on mass balance calculations, the KGC volcanoclastic deposits had an initial porosity of up to 85 vol.% and those of the MC about 65 vol.%. Secondary porosities (27 vol.%: MC, 8 vol.%: KGC) result from K-metasomatism proportional to the dissolution of Fe, Ca, Mg-rich glass and precursor minerals. Komatiites have a higher chemical exchange potential than dacites, each gram releasing 1.2 mmol Fe^{2+}, 2.8 mmol Mg^{2+}, 1.4 mmol Ca^{2+} and 1.1 mmol Na^{+} together with 4.4 mmol O^{2-} to seawater. During K-metasomatism, one gram of komatiite takes up 0.67 mmol of K^{+} and 2.7 mmol of H^{+}. KGC take up most silica (82 mmol/g of precursor). It is suggested that this silica enrichment operated in the water column and at the sediment-water interface by sorption on the surface of detrital particles and particulate organic matter, as a result of seawater silica-saturation. The formation of K-rich phyllosilicates by interaction with seawater during the early diagenetic alteration of the volcanoclastic particles. was favored by acidic conditions (pH 5.5-6.5) and hot temperatures (> 70°C). The widespread occurrence of K-Si-metasomatism in volcanic and sedimentary rocks can be regarded as a general alteration process of the Early Archean seafloor, as major controlling process for the seawater composition.

Contamination and heterogeneity in the mantle beneath the alkaline Monteregian Province (Québec): Evidence from geochemical and Nd-Sr isotope data

E. ROULLEAU* AND R. STEVENSON

GEOTOP research center, CP 8888 Succ. Centre Ville Montreal (Qc), H3C 3P8, Canada (*correspondence: roulleau.emilie@courrier.uqam.ca) (stevenson.ross@uqam.ca)

The Monteregian Igneous Province is a product of continental magmatism and constitutes nine plutons with associated dykes that were emplaced in southern of Québec ca 124 Ma ago (+/-1.5 Ma). Previous geochemical and isotopic studies have suggested that the magmas that formed these intrusions were derived from shallow or deep mantle sources with variable crustal contamination.

Geochemical and isotopic (Nd-Sr isotopes) analyses of mafic units from the Monteregian intrusions reveal compositions similar to those of ocean island basalts (OIB) associated with mantle plume dynamics. This includes enriched abundances of light Rare Earth Elements (REE) and High Field Strength Elements (HFS). The isotopic compositions of the intrusions are characterized by lower Nd and higher Sr isotope ratios than those of the normal depleted mantle. Part, but not all, of this variation likely reflects crustal contamination of the magmas during their ascent through the continental crust. This contamination can be modelled using assimilation-fractional crystallization (AFC) calculations based on contamination by incorporation of Grenville, St. Lawrence Lowlands or Appalachian crusts. This modelling yields good results for samples with lower incompatible element concentrations (e.g Nb-poor), but poor results for samples with higher incompatible element (Nb-rich) samples. This suggests that incompatible element enriched samples preserve an original mantle signature that is equivalent to the HIMU plume component observed in present-day ocean island basalts whereas contaminated samples preserve evidence of contamination of the plume during its ascent through the continental crust.