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Titre du projet: ***Temperatures of mantle sources of mid-ocean ridge basalts, ocean island basalts and Archean komatiites***

Volet: ***Recherche***

Porteur du projet: ***SOBOLEV Alexander****.*

Laboratoires impliqués: ***ISTerre, Geochemistry 4D***

Bilan du projet pour l'année/la période 2014-2015

Bilan d'activité *(1 page max)*

We report the first measurements of the contents of water and other volatiles, major and trace elements in melt inclusions in exceptionally highly magnesian olivine (up to Fo 94.5 mol%), and direct estimates of the composition and crystallization temperature of the parental melts of Archean komatiites **(Sobolev et al, 2015)**. We show that the parental melt for 2.7 Ga old komatiites from the Abitibi belt, Canada contained 29 wt% MgO and 0.7 wt% H_2O, and was depleted in highly incompatible elements. This melt started to crystallize at over 1500^{o}C at shallow depth and under reducing conditions, and it evolved via fractional crystallization of olivine and crustal assimilation. Its major and trace elements composition and low oxygen fugacities are inconsistent with a subduction setting. We propose that the unusually high ratio of H_2O to elements of similar compatibility (H_2O/Ce up to 7500) was caused by entrainment into the komatiite source of hydrous material from the mantle transition zone. These results confirm a plume origin of komatiites and high Archean mantle temperatures, and evoke a hydrous reservoir in the deep mantle early in the Earth history.

We report new high precision analytical method for trace element analysis of olivine for JEOL JXA-8230 electron probe microanalyser (**Batanova et al, 2015**). The facility has a tungsten source gun and is equipped with five wavelength-dispersive spectrometers (WDS) and one silicon drift detector energy-dispersive spectrometer (SDD, EDS). It is placed in an environment with closely controlled temperature (+/−0.5 °C) and humidity (+/−4%). The analytical conditions are as follows: acceleration voltage 25 kV, 900 nA beam current; WDS detection for trace elements (Ni, Mn, Ca, Al, Cr, Co, Ti, Zn, P, Na) and EDS detection for Si, Mg and Fe; total counting time 12min; ZAF correction. The analyzed volume is a half-sphere with a diameter of approximately 7 µm for most elements or a cylinder with a diameter of 7 µm and depth of approximately 2 µm for Al and Na. Instrumental drift during analytical sessions was monitored by repeated measurements of olivine standards. For trace elements, the method yields detection limits from 4 to 10 ppm and similar precision of individual analyses (2 standard errors). The detectable amount of an element is down to 2 *10−15 g and the precision for Fo in olivine is 200–300 ppm (2 standard errors). Comparison of data obtained using the EPMA with laser ablation inductively coupled plasma mass spectrometry (LA-ICP-MS) for a large range of olivine compositions confirms the accuracy of the EPMA which is similar to the precision noted above.

We present geochemical analyses as well as Sr–Nd–Pb–Hf isotopes of lavas and high-precision olivine analyses (**Delavault et al, 2015).** Using in situ olivine analyses and REE modeling, we constrain the composition of the mantle source (5% recycled oceanic crust – 95% peridotite), how both

components melt (25–30% versus 0.5–1.5%) and we estimate the temperature of Gambier source at about 1400◦C, a rather low temperature compared to Hawaii for example. We also constrain both the age and the nature of the recycled material using the isotopic data. They require the presence of about 3% sediment associated to recycled basalt in the pyroxenitic component and its age is about 1.5Gyr. We also attribute the marked Nb–Ta positive anomalies and the elevated Ce/Pb ratios to the presence of recycled basalt in the mantle source. These features resemble typical HIMU lavas but the younger age of the recycled material together with the presence of sediment in the plume source explains he lower Pb isotopic ratios. The clear isotopic change between Gambier and Pitcairn Islands suggests that the plume source changed radically within 5 Ma. More generally, our new data and model suggest that the FOZO composition as sampled by Gambier lavas does not necessarily represent a large and rather primitive mantle source.

Production scientifique

1. **Sobolev A.V.,** Asafov E.V., Gurenko A.A., Arndt N.T., Batanova V.G., Portnyagin M.V., Garbe-Schönberg D. and S. P. Krasheninnikov (2015). Komatiites reveal an Archean hydrous deep-mantle reservoir. *Nature* (in press).

2. Batanova V. G., **Sobolev A. V**. and Kuzmin D.V. (2015). Trace element analysis of olivine: High precision analytical method for JEOL JXA-8230 electron probe microanalyser. Chemical *Geology* **419**, 149–157**.**

3. Delavault H., Chauvel C., **Sobolev A.V.** and Batanova V.G. (2015). Combined petrological, geochemical and isotopic modeling of a plume source: Example of Gambier Island, Pitcairn chain. *Earth Planet. Sci. Letters* **426**, 23-35.

Bilan financier succinct *(avec suivant les cas : co-financements éventuels, équipements achetés, missions, recrutements divers, fonctionnements divers…)*

Coller ici le bilan financier

Total crédits reçus **10900**

Libellé	**Fournisseur**	**Montant Facture**
Holder for thin-sections for JEOL jxa-8230	JEOL	2631
Reserve tap water cooling system for JEOL jxa-8230	Dumolard SAS	1978.78
Consumables: éthanol, gel, gunts, essayeurs	SODIPRO	397.1
EPMA analysis	UJF	4900
Briand Jeremy	B. Jeremy, Master 2	1000
TOTAL		10906.88