MINERAL COMPOSITIONS AND RE-OS ISOTOPE SYSTEMATICS OF HARZBURGITIC NODULES FROM THE PANDA KIMBERLITE, SLAVE CRATON

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INTRODUCTION

The Panda kimberlite is located in the central parts of the Slave craton, just east of an inferred north-south trending suture between the Central Slave Basement Complex (CSBC) in the west and the eastern Slave terrain in the east (Davis and Hegner, 1992; Bleeker et al., 1999). The suture likely projects eastward into the lower crust of the eastern terrain (Davis and Hegner, 1992; Davis et al., 1999). While the CSBC shows a record of mainly meso-Archaean crustal formation events (>2.9 Ga; Bleeker et al., 1999 and references therein), the eastern Slave basement is predominantly neo-Archaean in age (Davis and Hegner, 1992; Davis et al., 1994). In an attempt to constrain the origin of the Panda mantle and its relation to the overlying crust, we have analysed a set of harzburgitic xenoliths for mineral compositions and Re-Os isotope systematics.

MINERALOGY

The nodules are dominated by garnet, which makes up 80-90 modal%. Orthopyroxene makes up 10-20 modal% of the individual nodules while chromite occurs as an accessory phase although in some nodules it is fairly abundant. Thus, from a mineralogical point of view, a correct classification of the samples would be orthopyroxene and chromite bearing garnet nodules. However, the lack of clinopyroxene and the low Ca contents in the garnets indicate a Ca undersaturated environment wherefore the term harzburgite has been adopted.

Preliminary electron microprobe analysis shows that the garnets carry 8-10 wt.% Cr_2O_3 and 3-4 wt.% CaO. Thus, they are distinctly sub-calcic indicative of the presence of diamonds. The chromite compositions similarly indicate the presence of diamond with chrome contents of ~60 wt.% Cr_2O_3. Preliminary geothermobarometry suggests that the nodules were sampled by the kimberlite at a pressure of about 50 kbar. This would be well into the diamond stability field at the prevalent geothermal conditions in this area.

RE-OS CONCENTRATIONS AND ISOTOPE SYSTEMATICS

The Os contents of the xenoliths are similar to what is normally observed for peridotitic xenoliths from on-craton kimberlites while the Re contents are comparatively low (Figure 1). As a consequence, the Panda harzburgites display very low Re/Os ratios (Re/Os≤0.01). The nodules studied here are rather small (~1-4 cm across) and their Re and Os contents are dependent the modal mineralogy, which may not be representative of the environment they originate from. However, since all the samples display low Re/Os ratios, this is believed to be characteristic of the sampled mantle.

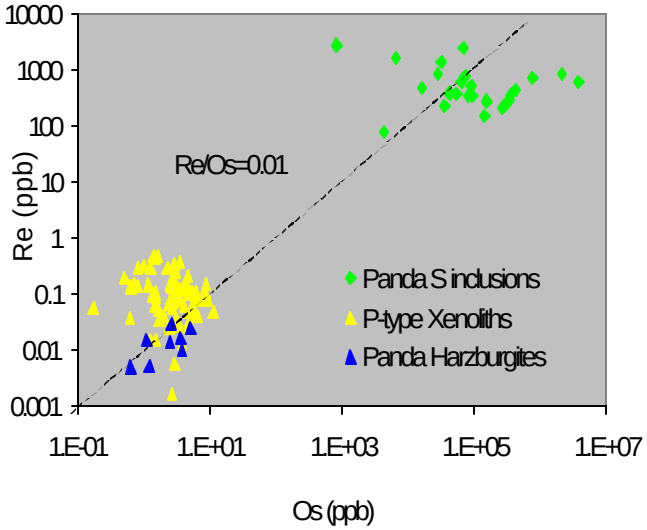

Figure 1: Re and Os concentrations for Panda xenoliths compared with those of Panda peridotitic sulfide inclusions in diamond Westerlund et al., this volume) and peridotitic xenoliths from other on-craton kimberlites (Carlson and Irving, 1994; Pearson et al., 1995a; Pearson et al., 1995; Carlson et al., 1999).

Re-Os model ages may be spurious if the modal mineralogy of a xenolith is not representative of the bulk environment or if secondary Re has been added to the sample. However, Re-depletion ages assume that the rock was initially devoid of Re and thus, will give a minimum age for a melt-depletion event. Similar to true model ages, Re-depletion ages are estimated assuming a chondritic mantle source. The Re-depletion and Re-Os model ages define narrow ranges due to the low Re contents in the xenoliths (Figure 2). Re-depletion ages (T_{RD}) for the harzburgites range from 2.7 to 3.1 Ga and the model ages (T_{MA}) range from 2.8 to 3.4 Ga. The model ages approach the 3.4 Ga isochron age obtained for sulfide inclusions from peridotitic Panda diamonds (Westerlund et al., this volume).

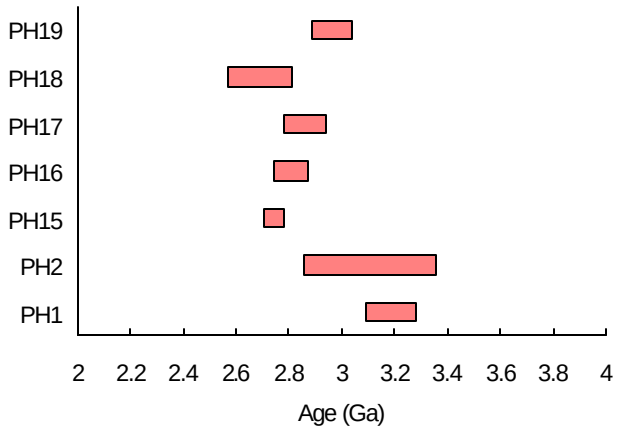

Figure 2: Ranges in Re depletion age to model age for the individual harzburgites.

DISCUSSION AND CONCLUSIONS

The low Re/Os ratios of the harzburgites are indicative of severe melt-depletion, which occurred sometimes in the mid-late Archaean as indicated by the unradiogenic Os isotope compositions of the nodules. Similar to a proposed shallow origin for some peridotitic diamonds from the Panda kimberlite (Westerlund et al., this volume a), geobarometry suggests a relatively shallow depth of origin within the diamond stability field for the analyzed harzburgites. Further, the harzburgites are rich in chromite similar to the "shallow" diamonds (Westerlund et al., this volume a) and they display very low Re/Os ratios similar to the sulfide diamond inclusions (Westerlund et al., this volume b). This may imply that the harzburgites and the diamonds are genetically connected and that the harzburgites are mid-Archaean rather than late-Archaean in age. It has been proposed that Panda diamond inclusion sulfides were derived from a source with a slightly suprachondritic $^{187}Os/^{188}Os$. The measured $^{187}Os/^{188}Os$ of the xenoliths is similar to substantially lower than that of the sulfide diamond inclusions at 3.4 Ga. Thus, if the two are indeed co-genetic, a source with a heterogeneous Os isotope composition is implicated. The range down to mid-Archaean Re-depletion ages could partly be explained by isotopic resetting during significant late-Archaean crustal formation events around 2.7 Ga. Also, the younger model ages could be explained by Re-loss during such an event.

Most Re-depletion ages exceed the main crustal formation ages of the eastern Slave terrain and many of the model ages over-lap with CBSC formation ages. This is indicative of a genetic decoupling between the crust intruded by Panda and the mantle which it has sampled and further suggests that the east-ward projected deep crustal suture continues into the deep mantle.

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