Melt generation in the West Antarctic Rift System: The volatile legacy of Gondwana subduction?

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The West Antarctic Rift System (WARS) represents one of the largest extensional alkali volcanic provinces on Earth, yet the mechanisms responsible for driving rift-related magmatism remain controversial. The failure of both passive and active models of decompression melting to adequately explain the observed volume of volcanism has prompted debate about the relative roles of thermal plume-related melting and ancient subduction-related flux melting. The latter is supported by roughly 500 Ma of subduction along the paleo-Pacific margin of Gondwana prior to the breakup of this supercontinent beginning in the Jurassic, although both processes are capable of producing the broad seismic anomaly imaged beneath most of the Southern Ocean. Olivine-hosted melt inclusions from basanitic lavas provide an unambiguous means to evaluate the volatile budget of the mantle responsible for active rifting beneath the WARS. We present H_2O, C, Cl, F, and S concentrations determined by SIMS for 5 WARS lavas from Northern Victoria Land (NVL) and Marie Byrd Land (MBL). Initial results for the lavas exhibit water contents ranging from 0.5 up to 3 wt % that are positively correlated with Cl and F. Coupling between Cl and H_2O indicates metasomatic enrichment by subduction-related fluids produced during dehydration reactions; coupling between H_2O and F, which is more highly retained in subducting slabs, may be related to partial melting of slab remnants [1]. Application of source lithology filters [2] to major oxide data shows that primitive lavas (MgO wt % >7) from the Terror Rift, considered the locus of on-going tectonomagmatic activity, have transitioned from a pyroxenite source to a volatilized peridotite source over the past ~4 Ma. Integrating the volatile data with the modelled characteristics of source lithologies suggests that partial melting of lithosphere modified by subduction processes is the source of pyroxenite and volatiles in the mantle beneath the present-day rift. The earliest magmatic activity preferentially removed the most readily fusible components from the mantle, resulting in transition to a metasomatized peridotite source over time.

[1] Straub & Layne, (2003), *GCA* [2] Herzberg & Asimow, (2008), *G^3* [3] Rilling *et al*, (2009), *JGR*.

Modeling the evolution of the isotopic composition of atmospheric xenon through time

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Even if the isotopic compositions of terrestrial H, N and Ar are clearly chondritic, atmospheric xenon is not chondritic in two ways : it is depleted relative to lighter noble gases, and it is isotopically enriched in its heavy isotopes relative to chondritic or solar components (the so-called xenon paradox). Recently, xenon trapped in Archean samples was found to be isotopically intermediate between Chondritic and Atmospheric [1], which was interpreted as resulting from prolongated loss of atmospheric xenon to space at least until the Archean eon. Such preferential loss could be related to the low ionization potential of Xe and, possibly, to the 10 fold enhanced flux of hard UV light during the first Ga of solar evolution [2].

In order to explore the geochemical consequences of this possibility, we have developped a numerical box model in which atmospheric xenon evolves through time due to degassing from the mantle with no isotopic fractionation, and escapes from the atmosphere to the outer space with enrichment in its heavy isotopes. The model is constrained by the initial conditions (cosmochemical Xe isotopic composition from the literature; Xe initial abundance equivalent to a few % carbonaceous chondrite [3]), the variation in the Xe isotope composition through time [1,4] and the present-day Xe composition of the mantle and of the atmosphere.

The combination of the two processes, permits to reproduce with accuracy (few % difference) the current isotopic composition of the Earth's atmosphere. In particular, the model explains the well known but unexplained atmospheric under-abundance of Xe isotopes from the fission of ^{244}Pu ($T_{1/2}$ = 82 Ma). When corrected for prolongated Xe loss into space, the I-Pu-Xe age of the atmosphere shifts from >100 Ma to 45±5 Ma.

[1] Pujol *et al* (2011) *EPSL* **308**, 298-306 [2] Ribas *et al* (2005) *The Astrophysical Journal* **622**, 680-694 [3] Marty (2012) *EPSL* **313-314**, 56-66 [4] Pujol *et al* (2009) *GCA* **73**, 6834-6846

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