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Volatile Release From The Siberian Traps Inferred From Melt Inclusions

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The Siberian Traps Large Igneous Province is one of the largest known continental flood volcanic provinces in the Phanerozoic. The quantification of volatile degassing is particularly important because the Siberian Traps have often been invoked as a possible trigger for the end-Permian mass extinction (e.g. Campbell et al., 1992; Wignall, 2001). Volatile degassing provides a crucial mechanism to link mafic volcanic eruption with global environmental change.

Mafic flood basalt magmas are expected to have low volatile contents (similar to mid-ocean ridge basalts). However, Siberian Traps magmas were chambered in and erupted through a thick sedimentary basin and may have interacted with, and obtained volatiles from, sedimentary lithologies such as limestone, coal, and evaporite. Melt inclusions from the Siberian Traps provide insight into the potential total volatile budget throughout the evolution of the large igneous province. These droplets of trapped melt may preserve volatile species that would otherwise have degassed at the time of eruption.

We present data from the analysis of more than 100 melt inclusions, including both homogenized inclusions and rare glassy inclusions with low crystallinity. Many melt inclusions from tuffs and flows near the base of the Siberian Traps sequence are substantially enriched in chlorine and fluorine compared to Deccan Traps and Laki melt inclusions (Self et al., 2008; Thordarson et al., 1996). These inclusions record chlorine concentrations up to $\sim$1400 ppm, and fluorine concentrations up to $\sim$5000 ppm. Olivines from the Maymechinsky suite, recognized as the last extrusive products of Siberian Traps volcanism, contain melt inclusions with maximum sulfur concentrations in the range of $\sim$5000 ppm and substantial concentrations of chlorine. Intrusive igneous rocks from the province also display significant volatile contents. A sill from the Ust-Ilimsk region yielded plagioclase-hosted melt inclusions which contain chlorine and fluorine concentrations in the range of one weight percent.

Visscher et al. (2004) proposed that chlorofluorocarbon compounds (CFCs) may have played a major role in the terrestrial end-Permian extinction. These CFCs are powerful catalysts for the breakdown of ozone, a process which can expose the biosphere to increased ultraviolet radiation. Measurements of elevated chlorine and fluorine from the Siberian Traps may thus provide a concrete source for CFCs that could have triggered this kill mechanism.