Evidence for Archean hydrous deep-mantle reservoir provided by Abitibi komatiites

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Archean komatiites result from melting under extreme conditions of the Earth's mantle. Their chemical compositions evoke very high eruption temperatures, up to 1600°C, providing clues to still higher temperatures in their mantle source [1]. This message is clouded, however, by uncertainty about the water content in komatiite magmas. One school holds that komatiites were essentially dry and originated in mantle plumes [2] while the other argues that these magmas contained several percent of water, which drastically reduced their eruption temperature and links them to subduction processes [3].

We report contents of water and other volatile components, major and trace elements in melt inclusions in olivine (up to Fo 94.5 mol%) and direct estimates of the composition and crystallization temperature of the parental melts of 2.7 Ga old komatiites from the Abitibi belt, Canada [4]. We show that their parental melt contained 30 wt.% MgO 0.6 wt.% H_2O, and yielded a potential temperature of 1725± 50ºC. This melt began to crystallize at around 1510ºC at shallow depth and under reducing conditions (QFM-1), and it evolved via fractional crystallization of olivine, accompanied by minor crustal assimilation. As its major and trace element composition are inconsistent with a subduction setting, we propose that the unusually high ratio of H_2O to elements of similar compatibility (H_2O/Ce > 6000) was caused by entrainment into the komatiite source of hydrous material from the mantle transition zone [5]. 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.

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