

The ^{205}Pb - ^{205}Tl and Cd isotope systematics of ordinary chondrites

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This study investigates the early history of the ordinary chondrite parent bodies using the ^{205}Pb - ^{205}Tl decay system. The presence of short-lived ^{205}Pb ($t_{1/2}=15.1$ Ma) in the early Solar System [1-2] and large variations in the Pb/Tl ratios of ordinary chondrites make the ^{205}Pb - ^{205}Tl system suitable for chronological studies of these bodies. To minimize the problem of terrestrial Pb contamination, only meteorite falls have been selected for study. The LL-chondrites analysed give a Pb-Pb age of 4.53 ± 0.11 Ga, suggesting that their Pb budget is not dominated by terrestrial lead.

The ordinary chondrites display a spread in $^{204}\text{Pb}/^{203}\text{Tl}$ ratios from 1.7 to 152, primarily controlled by a large variation in Tl concentration (from 0.3 to 19 ppb). Lead concentrations vary less, but still differ by a factor of 7. The Tl isotopic composition of unequilibrated chondrites (type 3) indicates radiogenic in-growth of ^{205}Tl , suggesting a relative Pb-Tl age similar to that of the IAB iron meteorites [1]. Equilibrated LL and L chondrites (type 4-6), on the other hand, show no evidence of radiogenic ^{205}Tl . This indicates that their high Pb/Tl ratios were established later than 4.45 Ga, suggesting a longer cooling history for the LL chondrite parent body than seen for the H-chondrite parent body [3-4], or a resetting of the Pb-Tl system after this time, perhaps due to impact-induced thermal metamorphism [5].

The element Cd has approximately the same volatility as Tl. Hence, Cd stable isotope analyses are used to identify samples where the Tl isotope compositions were altered by stable isotope effects from mobilization of Tl during thermal metamorphism [6].

[1] Nielsen, Rehkämper & Halliday (2006) *GCA* **70**, 2643-2657. [2] Baker, Schönbachler & Rehkämper (2007) *LPSC XXXVIII*, 1840. [3] Trieloff *et al.* (2003) *Nature* **422**, 502-506. [4] Kleine *et al.* (2008) *EPSL* **270**, 106-118. [5] Rubin (2004), *GCA* **68**, 673-689. [6] Wombacher *et al.* (2008) *GCA* **72**, 646-667.

Silicate and salt (Li, Na, F) melts of the Dzarta Khuduk rare-metal occurrence (Central Mongolia)

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Using electron and ion microprobe analysis, we investigated inclusions of mineral-forming media in minerals from the rare-metal (Nb, Zr, and REE) alkali-rich felsic rocks of the Late Paleozoic bimodal volcanic association of the Dzarta Khuduk occurrence (Central Mongolia). Dzarta Huduk paleovolcano occupies an area of more than 120 square kilometers. A sequence of felsic agpaite volcanics rests on subalkali basalts and consists of intercalating alkaline trachydacites, pantellerites, and comendites. Their mineralogical and chemical characteristics correspond to silicic peralkaline rocks of the K-Na series with an agpaite coefficient (K_a) of >1 and high contents of F, Zr, Li, Rb, and REE. Primary solid and melt inclusions were determined in quartz of the comendites and comendite tuffs. Aegirine, fluorite, ilmenite, and chevkinite (rare REE di-orthosilicate with 21 wt % Ce_2O_3 , 17 wt % La_2O_3 , 1 wt % Nb_2O_5 , and 0.5 wt % Y_2O_3) were found as single-phase inclusions. The melt inclusions in comendites are composed of glass, gas phase, and a fine-grained villiaumite (NaF)-griceite (LiF) aggregate.

The melt inclusions in comendite tuffs are composed of homogeneous glass and can be considered as residual melts formed during the crystallization of comendite magma.

Thermometric experiments with melt inclusions in comendites were conducted using a microscopic heating stage allowing fast quenching (within 1-2 s). The complete homogenization of melt inclusions was observed at 800–1030°C. The glasses of homogenized inclusions are chemically similar to the host comendites and contain (wt %): 72–80 SiO_2 , up to 5 FeO , 4–7 Na_2O , 3.6–4.7 K_2O , and 7.8–11.0 Al_2O_3 . A conspicuous feature of these melts is extremely high Li and Zr contents, up to 1800–1900 and 1300–3700 ppm, respectively. In addition, the melts show high Rb (300–600 ppm), Nb (100–235 ppm), Y (110–240 ppm), Ce (up to 290 ppm), and La (up to 120 ppm), but very low Sr (2–5 ppm) and Ba (5–9 ppm) abundances. The contents of volatile components are 0.4–1.4 wt % H_2O , 0.8–2.8 wt % F, and up to 0.3 wt % Cl. The glasses from comendite tuffs are even stronger enriched in Zr, Th, Rb, and Sr. The concentrations of Zr in glasses from the tuffs are higher than 1 %. The majority of trace elements (Rb, Pb, U, Ta, Y, Th, and almost all REE) show direct correlations with Nb. Thus, our study of melt inclusions in quartz from comendites and comendite tuffs revealed the occurrence of strongly evolved rare-metal alkaline melts enriched in Na, F, Li, Zr, and REE and allowed us to distinguish main magmatic processes responsible for their formation. The evolution of the comendite melt was controlled by the processes of crystal fractionation and silicate-salt liquid immiscibility.