Secular change of the chromite concentration process from the Archean to Phanerozoic

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We examine the secular change of properties of podiform chromitites and their host peridotites to understand the evolution of the upper mantle through Earth's history. Podiform chromitites are very rare in the Archean ophiolites. They got gradually abundant in ophiolites from the early Proterozoic to the Phaneorozoic. The size of chromitite pods is mostly small (1 to 20 m x 0.5 to 3 m) in the Precambrian ophiolites, while remarkably larger (up to hundreds meters x several tens of meters) in the Phanerozoic ophiolites. The Archean chromitites show a very restricted and highly refractory composition of chromian spinel: Cr# [Cr/(Cr + Al)] from 0.74 to 0.93 and TiO_2 content less than 0.3 wt%. The Cr# of spinel in the host harzburgite is also high, around 0.7. In the late Proterozoic ophiolites, podiform chromitites are much more abundant than in the Archean and early Proterozoic ones. Al-rich chromitite varieties started to appear in the late Proterozoic ophiolites, although the majority are Cr-rich.

Podiform chromitites are very common and large in size in the Tethyan ophiolites of the late Paleozoic to Mesozoic age. Their host mantle peridotites have a wide range of spinel composition with an intermediate Cr#, around 0.5, serving as the most common host for large podiform chromitites in the Phanerozoic ophiolites. With a few exceptions all known Phanerozoic ophiolites have less refractory peridotites and chromitites than t the Precambrian ophiolites. Diversity in chromian spinel chemistry and PGE contents in podiform chromitites become more distinct in the Phanerozoic ophiolites.

If the tectonic setting of ophiolite formation has been kept the same, the distribution of Cr within the mantle to crust has been changed possibly with time. Larger amounts of Cr were possibly transported to the crust by high-degree partial melts and concentrared as the stratiform chromitite in the Precambrian, and, in contrast, have been stored as the podiform chromitite within the mantle as podi in younger times in the Earth's history.

Archean regional metamorphism of the 3.8-3.7 Ga Isua Greenstone Belt, SW Greenland: Geothermal gradient of the Archean subduction zone and implication for global carbon cycle

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The 3.7-3.8 Ga Isua Supracrustal Belt (ISB), southwest Greenland, constitutes the oldest accretionary complex on Earth [1]. Detailed microscopic and microprobe analyses of metabasites in the area revealed that the western ISB underwent regional metamorphism from lower to upper amphibole facies, which record subduction-related progressive metamorphism [1]. Analysis of isochemical phase diagram of the metabasites quantitatively estimated the Archean geothermal gradient along the subducting plates as an intermediate P/T-type metamorphic series. In addition, the correlation of the modal abundance of carbonate minerals in the MORB-related metabasites with its metamorphic grade suggests that the carbonate minerals were formed prior to its subduction at the convergent boundary. Subduction of carbonatized oceanic crusts is considered as one of the main mechanism to reduce the atmospheric CO_2 [2]. Previous works reported that the less metamorphosed 3.1 Ga Archean MORB in Pilbara Craton, Western Australia, contain 30 vol% of carbonate minerals on average, due to the hydrothermal carbonation reaction with the CO_2-rich Archean seawater at the mid-ocean ridge [2], whereas 3.8Ga Archean MORB in the study area rarely contain carbonate minerals. Comparison of the Archean geothermal gradient and stability fields of carbonate minerals of the metabasite suggests that most of carbonate minerals in the oceanic crusts could not have been stably transported into the mantle under the geothermal gradient. The line of evidence indicates that most of the carbonate minerals trapped in the oceanic crusts could have returned to the surface at the subduction zone at least in the Archean 3.8Ga even though the Arcehan oceanic crusts were highly carbonated.

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[2] Shibuya *et al* (2012) *EPSL* **321-322**, 64-73.

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