Petrogenesis of basalts from Emeishan large igneous province constrained from major element, trace element and Pb isotope compositions of olivine-hosted melt inclusions

*Zhong-Yuan Ren[1], Ya-Dong Wu[1], Le Zhang[1], Alexander R. L. Nichols, Lu-Bing Hong[1], Yin-Hui Zhang, Yan Zhang, Jian-Qiang Liu, Yi-Gang Xu[1]

1. State Key Laboratory of Isotope Geochemistry, Guangzhou Institute of Geochemistry, Chinese Academy of Sciences

Large igneous provinces (LIPs) are produced by some of the largest known volcanic episodes on our planet. The Emeishan LIP in SW China is one of the most significant LIPs in the world as it comprises several world-class giant V-Ti magnetite deposits and possesses some Cu-Ni-(PGE) sulphide deposits. In addition, the Emeishan LIP is thought to be one of the best examples of a LIP generated by a mantle plume. Furthermore, the Emeishan volcanism might have caused the end-Guadalupian mass extinction. In the last few decades, numerous petrological, geochemical, paleontological, paleomagnetic, geophysical, geochronological, and mineral deposit studies have been conducted on the Emeishan LIP. Despite the breadth of understanding, there are still many controversies concerning the compositions of the primary magmas, the lithology of their sources, and the melting processes in the sources. It has long been believed that the source of the Emeishan basalts is peridotite, either from a mantle plume or the sub-continental lithosphere. Olivine-hosted melt inclusions within lava retain information regarding the lava’s primary magma compositions and mantle sources. Thus, they can be used to infer the nature of the mantle sources of large igneous provinces, which is still not well known and of the subject of debate. We have analyzed the chemical compositions and Pb isotopic ratios of olivine-hosted melt inclusions in the Dali picrites, Emeishan Large Igneous Province (LIP), SW China. These are the first *in-situ* Pb isotope data measured for melt inclusions found in the Emeishan picrites and allow new constraints to be placed on the source lithology of the Emeishan LIP. The melt inclusions show chemical compositional variations, spanning low-, intermediate- and high-Ti compositions, while their host whole rocks are restricted to the intermediate-Ti compositions. Together with the relatively constant Pb isotope ratios of the melt inclusions, the compositional variations suggest that the low-, intermediate- and high-Ti melts were derived from compositionally similar sources. The geochemical characteristics of melt inclusions, their host olivines, and whole-rocks from the Emeishan LIP indicate that Ca, Al, Mn, Yb, and Lu behave compatibly, and Ti, Rb, Sr, Zr, and Nb behave incompatibly during partial melting, requiring a pyroxenite source for the Emeishin LIP. The wide range of Ti contents in the melt inclusions and whole-rocks of the Emeishan basalts reflects different degrees of partial melting in the pyroxenite source at different depths in the melting column. The Pb isotope compositions of the melt inclusions and the OIB-like trace element compositions of the Emeishan basalts imply that mixing of a recycled ancient oceanic crust (EM1-like) component with a peridotite component from the lower mantle (FOZO-like component) could have underwent solid-state reaction, producing a secondary pyroxenite source that was subsequently partially melted to form the basalts. This new model of pyroxenite melting could explain the geochemical variations among the low-, intermediate- and high-Ti basalts for the Emeishan LIP and challenges the prevailing belief that the source of the Emeishan basalts is peridotite.

Keywords: large igneous province, pyroxenite source, Pb isotope of melt inclusion, olivine-hosted melt inclusion, mantle plume

