The Distinctive Isotopic Characteristics between the Paleo-Asian and Paleo-Tethyan Mantle Domain

LIU Xijun[1, 2, *], XIAO Wengjiao[2], XU Jifeng[3], Paterno R. CASTILLO[4] and ZHANG Zhiguo[1]

[1] *Guangxi Key Laboratory of Hidden Metallic Ore Deposits Exploration and Guangxi Collaborative Innovation Centre of Hidden Non–ferrous Metallic Ore Deposits Exploration and Development of Materials, Guilin University of Technology, Guilin 541004, Guangxi, China*

[2] *Xinjiang Research Center for Mineral Resources, Xinjiang Institute of Ecology and Geography, Chinese Academy of Sciences, Urumqi 830011,China*

[3] *School of Earth Sciences and Resources, China University of Geosciences, Beijing 100083, China*

[4] *Scripps Institution of Oceanography, UCSD, La Jolla, CA, 92093, USA*

Citation: Liu et al., 2019. The Distinctive Isotopic Characteristics between the Paleo-Asian and Paleo-Tethyan Mantle Domain. *Acta Geologica Sinica* (English Edition), 93(supp.2): 195.

Abstract: Global-scale mantle heterogeneities have been recognized through geochemical studies of oceanic basalts (Hart, 1984). The origins, properties and histories of such chemical heterogeneities provide keys to a better understanding of global mantle evolution during Earth history. One way to decipher the geology of the mantle is through long-lived radiogenic isotopes (Castillo, 1988). In this respect, Pb isotopes are a very powerful tool because Pb has four naturally occurring isotopes - the ~non-radiogenic ^{204}Pb and radiogenic ^{206}Pb, ^{207}Pb and ^{208}Pb isotopes, the half-lives of the radioactive parent elements U and Th are relatively short, and these radioactive parents are geochemically different from each other. These make ^{206}Pb/^{204}Pb, ^{207}Pb/^{204}Pb and ^{208}Pb/^{204}Pb isotope ratios sensitive tracers of different mantle reservoirs.

Ophiolites, pieces of ocean floor that are occasionally preserved on land, are interesting to study in this context since their trace element and isotopic characteristics generally reflect those of the composition and evolution of their underlying mantle (Xu and Castillo, 2004; Liu et al., 2014). They are an important source of direct information on the nature of their sources and can also provide opportunities to extrapolate mantle evolution through time (Mahoney, 1998; Xu and Castillo, 2004).

The Paleo-Asia and Tethys are two extinct ancient oceans. Paleo-Tethyan Ocean (PTO)and Paleo-Asian Ocean (PAO) have existed on Earth throughout the Paleozoic. Ophiolites representing relict fragments of the PAO and PTO crusts are preserved along the Central Asian Orogenic Belt and Tethyan Tectonic Zone, respectively. We analyze the geochemical and Pb, Nd and Sr isotopic compositions of representative mafic rocks from several Paleo-Asian Ocean ophiolites to constrain the isotopic evolution of its mantle domain that, in turn, will help us better understand mantle geodynamics during Earth's history. Data suggest that the Sr isotopic composition of PAO ophiolites do not represent primary magmatic composition due to alteration. Combined with similar data for mafic rocks from Paleo-Tethyan Ocean ophiolites, the Nd and Pb isotopic composition indicates the sub-PAO and -PTO mantles have had similar long time-integrated history of Sm/Nd enrichment but marked differences in their Th/Pb and U/Pb fractionation. The sub-PAO mantle produced a Pacific MORB-type mantle with lower ^{207}Pb/^{204}Pb$_{(t)}$ and ^{208}Pb/^{204}Pb$_{(t)}$ for given ^{206}Pb/^{204}Pb ratios than the sub-PTO mantle.

Key words: Paleo-Asian ocean, Paleo-Tethyan ocean, ophiolite, mantle domain

Acknowledgments: This work is granted by the National Natural Science Foundation of China (Grant No. 41772059) , CAS "Light of West China" Program (2018-XBYJRC-003) , Guangxi Natural Science Fund for Distinguished Young Scholars (Grant No.2018GXNSFFA281009), Guangxi Postgradute Innovation Project (Grant No. YCSW2019155).

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About the first author(also corresponding author)

LIU Xijun, male, born in 1980 in Zhangye City, Gansu Province; Ph.D; graduated from Guangzhou Institute of Geochemistry, professor of Guilin University of Technology. He is now interested in the study of isotope geochemistry, Email: xijunliu_sio@qq.com; phone: 15277395399.

* Corresponding author. E-mail: xijunliu@gmail.com