PETROLOGY AND IN SITU GEOCHRONOLOGY OF THE YOUXI MESOSIDERITE.

Y. Wang[1] and W. Hsu[1,2], [1]CAS Center for Excellence in Comparative Planetology, Purple Mountain Observatory, Nanjing 210034 (y_wang@pmo.ac.cn), [2]The State Key Laboratory of Lunar and Planetary Science/Space Science Institute, Macau University of Science and Technology, Taipa, Macau.

Introduction: Mesosiderites are roughly composed of equal mass proportions of metals and silicates, and have been widely regarded as mixtures of the core and crust materials of differentiated asteroids[1]. However, the timing and mechanism of the metal-silicate mixing remain enigmatic despite long and extensive debates. In order to unravel the formation age and origin of mesosiderites, we carried out petrologic, mineralogic, and geochronological studies of the Youxi mesosiderite.

Results and Discussion: Youxi was found in Youxi City, Fujian Province of China in 2006. It is composed of ~70 vol% of silicates and ~30 vol% of metals. Numerous well-defined lithic clasts exhibit diverse lithologies from basaltic to gabbroic, orthopyroxenitic, and rare peridotitic, silica-rich, and phosphate-rich ones. Mineral clasts are mostly orthopyroxene and plagioclase. Metal phases are mainly kamacite with minor taenite, troilite, and accessory schreibersite. The silicate part of Youxi has bulk REE compositions [(1.3-4.0)× CI; $(La/Lu)_{CI}$: 0.90; Eu/Eu*: 1.89] similar to HED meteorites. Mineral compositions of pyroxene ($En_{66.0\pm2.3}Wo_{2.5\pm0.6}$), plagioclase ($An_{92.7\pm2.4}Ab_{7.2\pm2.4}$), and olivine ($Fo_{61.5\text{-}77.8}$) are roughly consistent with those in HEDs. The petrographic, bulk and mineral chemical affinities of Youxi with those of HEDs indicate that the silicate part of Youxi might be genetically related with the parent body of HEDs.

Merrillite is ubiquitous (~2 vol%) in Youxi. Most are anhedral coarse grains (>100 μm) closely associated with Fe,Ni-metals. Different from the REE-enriched merrillite (La: 7600-25000 × CI) in eucrite[2], merrillite in Youxi has significantly lower REE abundances (~20-500 × CI; Fig. 1). Therefore, unlike the magmatic origin of eucritic merrillite, the phosphate in Youxi probably formed from oxidation of P in metallic phases during the metal-silicate mixing. In situ Pb-Pb dating was carried out on 53 merrillite crystals using the Cameca ims 1280 ion microprobe at the IGGCAS in Beijing. Our analyses yielded a $^{207}Pb/^{206}Pb$ age of 3950 ± 80 (2σ) Ma, which is close to the Ar-Ar age (~3.9 Ga) of mesosiderites[4] but distinctly younger than the ~4.5 Ga ages in literatures[e.g., 5].

Considering the cooling history of mesosiderites[1,6,7] (~5×10^3 to 2×10^6 °C/Myr at 1150-600 °C and ≤ 1 °C/Myr at ~500-350 °C), the diffusion of Pb isotopes in merrillite (T_c>450 °C)[8] should have come to closure within ~50 Myr after its formation. In addition, the secondary thermal and shock metamorphism of Youxi is minimal. Therefore, the $^{207}Pb/^{206}Pb$ age of 3950 ± 80 Ma represents the formation time of merrillite, and accordingly the time of metal-silicate mixing that had produced the Youxi mesosiderite.

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Acknowledgement: This work was supported by the National Natural Science Foundation of China (Grant No. 41573060, 41573059), Macau FDCT (005/2017/A1, 119/2017/A3, 0079/2018/A2), and the Minor Planet Foundation of Purple Mountain Observatory.

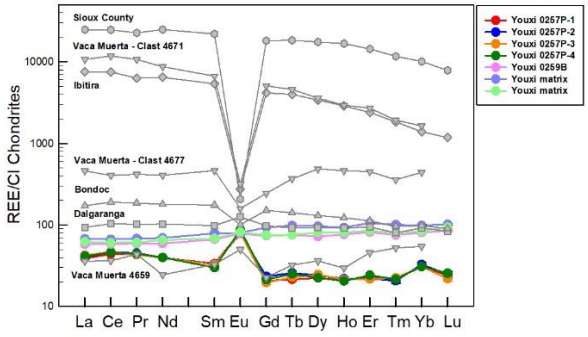

Fig. 1 CI-normalized REE abundances of merrillite in Youxi, compared with those of eucrites and other mesosiderites[2-3].

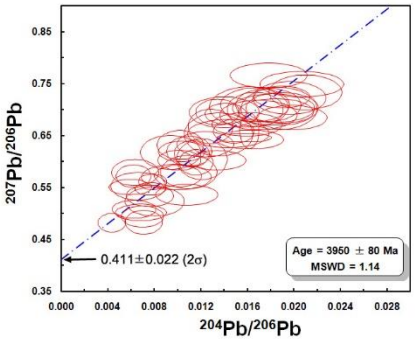

Fig.2 $^{207}Pb/^{206}Pb$ vs. $^{204}Pb/^{206}Pb$ plot of merrillites in Youxi. The intercept on Y-axis (0.411 ± 0.022, 2σ) corresponds to a Pb/Pb age of 3950 ± 80 (2σ) Ma.