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Titanite geochemistry traces extreme differentiation of granitic magma in the collisional orogen

PROF. YI-XIANG CHEN SR., PH.D[1] AND HE-ZHI MA SR.[2]

[1]School of Earth and Space Sciences, University of Science and Technology of China

[2]University of Science and Technology of China

Presenting Author: yxchen07@ustc.edu.cn

The formation process and geochemical differentiation of granitic magma is important for the growth and evolution of continental crust. However, it is still controversy on whether and how the granitic magma can have efficient crystal fractionation from partial melting at the source to magma emplacement in the shallow crust level. To constrain this problem, a combined study of whole-rock major and trace elements, *in situ* titanite geochemistry (major and trace elements, U–Pb ages and Nd isotopes) was carried out for syn-exhumation granites from the Sulu ultrahigh-pressure (UHP) metamorphic belt in east-central China. These high Si granites are produced by partial melting of deeply subducted continental crust. Significant geochemical differentiation has been revealed by whole-rock and mineral geochemistry. Titanite in the granite samples can be divided into anatectic and magmatic origins according to the Fe/Al ratios and trace elements like REE. Both types of titanite give similar U-Pb ages of 209 ± 23 Ma to 233 ± 26 Ma, corresponding to the exhumation stage of the Sulu UHP metamorphic belt. These titanites show consistent $\varepsilon_{Nd}(t)$ values, indicating that they formed in a nearly closed system without significant mixing of different sources of magma. One important observation is that, whereas the anatectic titanites mostly exhibit low Nb/Ta values, the magmatic titanites have highly variable Nb/Ta ratios of 3.8–1063, which show good correlations with FeO_t, Al_2O_3, Ta, Sr, LREE and Lu/Gd. This is ascribed to extensive crystal fractionation of titanite, plagioclase and allanite/epidote during magma evolution. Therefore, accessory minerals like titanite play a key role in constraining granite differentiation and titanite geochemistry can record complex geological processes of partial melting and fractional crystallization for the syn-exhumation granites.