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# Petrogenesis of high silica granites

**HUI HUANG**

China University of Geosciences, Beijing

Presenting Author: huihuang@cugb.edu.cn

High silica (>70 wt.% $SiO_2$) granites are important components of upper continental crust. They closely associate with rare earth elements (REE) and metal mineralization. Their distinct geochemical features (low Zr/Hf and Nb/Ta) have drawn a long-lasting debate, with proposed models ranging from fractional crystallization of mica to fluid interaction [1, 2]. The high silica granites from the Qilian Orogenic belt have Zr/Hf ratios varying from 15.8 to 30 and Nb/Ta ratios from 3.8 to 9.3, significantly lower than the chondritic values 36.5 and 17.6, respectively. Zr/Hf and Nb/Ta ratios show tight correlations with major, trace elements/ratios (e.g. REE, Eu/Eu*, Rb/Sr, K/Rb etc), boron isotopes ($d^{11}B$) as well as age corrected initial Hf isotopes (eHf(t)) and eNd(t). The data defines two components, one with high eHf(t), low Zr/Hf, low Nb/Ta, low Rb/Sr values and high Nb and Ta contents, the other with opposite compositions. Neither fluid interaction, fractional crystallization nor magma mixing can explain all the correlations well. We note that eHf(t) values positively correlate with $Fe_2O_3$ and negatively correlate with FeO, which indicates that high eHf(t) endmember associates with $Fe^{3+}$. $Fe^{3+}$ is hosted in titanite and rutile compared to other common minerals in high silica granites, e.g. apatite, epidote, mica and garnet. We proposed that the breakdown of rutile produces high Nb and Ta contents but low Nb/Ta and low Zr/Hf in the melt. Meanwhile, high eHf(t) is expected in the initial melt due to melting of non-zircon phases. Boron isotopes are also consistent with non-modal melting process. The $d^{11}B$ is high in plagioclase, moderate in biotite and low in muscovite [3]. In our study, $d^{11}B$ negatively correlates with Rb and positively correlates with Eu/Eu* and CaO, a phenomenon that can be explained by non-modal muscovite dehydration melting. As melting degree increases, more addition of plagioclase results in high $d^{11}B$, high Eu/Eu* and high CaO. Therefore, we consider low Zr/Hf and Nb/Ta in the high silica granites can be produced through non-modal dehydration melting, perhaps with enhancement of fractional crystallization or fluid interaction. [1] Stepanov et al., 2014, CMP. [2] Ballouard, et al., 2016, Geology. [3] Fan et al., 2021,GCA.