Geochemical signature and evolution of granitic rocks in Sulawesi Island, Indonesia: evidence for Gondwana involvement

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Tertiary granitic rocks from Sulawesi record series of complex history where subduction and collision occur and are still active. One of the products of these events is granitic magmatisms which are widely dispersed from southern part to northern part of the island. The granitic rocks were exposed to form a NS trending belt along the west to north plutono-volcanic arc province. The granitic rocks are of particular interest since they provide an insight into the geological processes that were operating at the eastern margin of Eurasian Plate.

In this study, major- and trace- element chemistry of granitic pluton from nine areas which represent the whole granitic distribution in Sulawesi Island were studied in order to elucidate the geodynamic evolution. In addition, the geochemical signatures coupled with isotopic results are used to determine the corresponding constraint on Gondwana involvement in the evolution of the island.

The results indicate that the granitic rocks ranges from acid to intermediate (granitic to tonalitic in composition) and are dominated by granodiorite with enclave of microdiorite and gabbro. They are identified as medium- to high-K, calc-alkaline, metaluminous and I-type granitoid emplaced as volcanic arc granites. With the exception of tonalitic rocks in Gorontalo area in the northern part of the island, all granitic samples resemble the upper continental crust pattern in their trace and rare earth element normalized pattern. Enrichment of large ion lithophile elements (Rb and Sr) and depletion of high field strength element (especially Nb and Ta) suggests an arc magma affinity. Negative Eu anomaly in most of the samples shows the occurrence of plagioclase fractionation in magma chamber. Most of the samples show high $^{87}Sr/^{86}Sr$ value but low $^{143}Nd/^{144}Nd$ suggesting strong upper crustal component source. In addition, they have high ^{206}Pb, ^{207}Pb and ^{208}Pb isotope ratios. However, microdioritic enclave and tonalitic rocks from Gorontalo shows lower $^{87}Sr/^{86}Sr$ value but higher $^{143}Nd/^{144}Nd$ and relatively higher ^{206}Pb, ^{207}Pb and ^{208}Pb value, significantly different from other samples.

The magma sources of these granitic rocks were interpreted derived from the upper continental crust. The most plausible nature of such affinity was Gondwana fragment which were dispersed during Cenozoic. They were then emplaced above subduction zone during the syn- to late collision stages with eastern part of Sundaland.

The overall geochemical signature of the Sulawesi granitic rocks suggests the evidence of Gondwana fragment involvement in geodynamic evolution of the island, particularly in the western and central Sulawesi.

Experimental investigations of the structural environment of metal (Nb, Ta) ions in silicate glass-water systems to high P-T conditions

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The study of silicate and aluminosilicate glasses and water systems at high P-T conditions has importance for understanding natural systems and for technological applications. The interrogation of the interaction of water in silicate melts and glasses on the structural level is critical for establishing a better understanding of the effect of dissolved water on the thermodynamic and physical properties of water-saturated magmas and of industrial glasses that are in contact with high P-T aqueous fluids. In this work, we discuss our *in situ* Ta L_3 and Nb K-edge x-ray absorption spectroscopic (XAS) investigations of the structural environment of metal (Nb, Ta) ions in haplogranitic glasses, water-saturated melts, and silicate-rich aqueous fluids at high temperatures and pressures. The starting materials, which consisted of water and a Ta (~1400 ppm)- or Nb (~5000 ppm)-bearing haplogranitic glass of peraluminous composition, were loaded into an hydrothermal diamond anvil cell and subjected to temperatures between 25 and 960 °C, and pressures up to 600 MPa. Pre-edge peak analysis of the Nb K-edge x-ray absorption near edge structure (XANES) measured from the Nb-bearing glass+water system to 760 °C shows a transition (in the 300 to 400 °C range) from a double to a single peak in the vicinity of the glass transition. In addition, the overall intensity of the pre-edge peak feature of the Nb-bearing glass+water system increases monotonically with increasing temperature. A doublet occuring in the white line feature of the Ta L_3-edge XANES is present in the spectra measured from the hydrous glass/melt to 700 °C and from the silicate-rich aqueous fluid at 960 °C. The white line feature results from dipole allowed transitions of the Ta $2p_{3/2}$ core electron to empty quasi-bound states in the continuum having Ta 5d atomic character. The Ta L_3-edge XANES spectra measured from a peraluminous silicate glass and water system have been analyzed using multi-peak fitting techniques. The normalized XANES spectra were fit in the vicinity of the white line using pseudo-Voigt peak functions. The relative intensities of the individual peaks in the Ta L_3-edge XANES white-line doublet vary with increasing temperature of the glass+water system, suggesting a shift in occupation of the electronic density of states in the vicinity of Ta 5d states probed by the $2p_{3/2}$ core photoelectron. *In situ* XANES is shown to be a sensitive probe of the modifications in the structural environment surrounding the metal (Nb, Ta) ion in the hydrated peraluminous glass/melt and in the silicate enriched aqueous fluid with increasing P-T conditions. We discuss the results of modeling of the XANES spectra and calculations of the projected angular momentum density of states (*l*-DOS) for the glass+water systems using FEFF code.