

Petrogenesis and Tectonic Implication of the Oligocene Na-Rich Granites from the North Sulawesi Arc, Indonesia

Authors : Xianghong Lu, Yuejun Wang, Chengshi Gan, Xin Qian

Abstract : The North Sulawesi Arc, located on the east of Indonesia and to the south of the Celebes Sea, is the north part of the K-shape of Sulawesi Island and has a complex tectonic history since the Cenozoic due to the convergence of three plates (Eurasia, India-Australia and Pacific plates). Published rock records contain less precise chronology, mostly using K-Ar dating, and rare geochemistry data, which limit the understanding of the regional tectonic setting. This study presents detailed zircon U-Pb geochronological and Hf-O isotope and whole-rock geochemical analyses for the Na-rich granites from the North Sulawesi Arc. Zircon U-Pb geochronological analyses of three representative samples yield weighted mean ages of 30.4 ± 0.4 Ma, 29.5 ± 0.2 Ma, and 27.3 ± 0.4 Ma, respectively, revealing the Oligocene magmatism in the North Sulawesi Arc. The samples have high Na₂O and low K₂O contents with high Na₂O/K₂O ratios, belonging to Low-K tholeiitic Na-rich granites. The Na-rich granites are characterized by high SiO₂ contents (75.05-79.38 wt.%) and low MgO contents (0.07-0.91 wt.%) and show arc-like trace elemental signatures. They have low (⁸⁷Sr/⁸⁶Sr)_i ratios (0.7044-0.7046), high εNd(t) values (from +5.1 to +6.6), high zircon εHf(t) values (from +10.1 to +18.8) and low zircon δ¹⁸O values (3.65-5.02). They show an Indian-Ocean affinity of Pb isotopic compositions with ²⁰⁶Pb/²⁰⁴Pb ratio of 18.16-18.37, ²⁰⁷Pb/²⁰⁴Pb ratio of 15.56-15.62, and ²⁰⁸Pb/²⁰⁴Pb ratio of 38.20-38.66. These geochemical signatures suggest that the Oligocene Na-rich granites from the North Sulawesi Arc formed by partial melting of the juvenile oceanic crust with sediment-derived fluid-related metasomatism in a subducting setting and support an intra-oceanic arc origin. Combined with the published study, the emergence of extensive calc-alkaline felsic arc magmatism can be traced back to the Early Oligocene period, subsequent to the Eocene back-arc basalts (BAB) that share similarity with the Celebes Sea basement. Since the opening of the Celebes Sea started from the Eocene (42~47 Ma) and stopped by the Early Oligocene (~32 Ma), the geodynamical mechanism of the formation of the Na-rich granites from the North Sulawesi Arc during the Oligocene might relate to the subduction of the Indian Ocean.

Keywords : North Sulawesi Arc, oligocene, Na-rich granites, in-situ zircon Hf-O analysis, intra-oceanic origin

Conference Title : ICGG 2023 : International Conference on Geology and Geophysics

Conference Location : Sydney, Australia

Conference Dates : August 24-25, 2023