American Mineralogist, Volume 70, pages 1151–1163, 1985

Petrology, geochemistry and origin of the Big Branch and Red Mountain gneisses, southeastern Llano Uplift, Texas

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Abstract

The 1.0–1.2 b.y. old rocks of the southeastern Llano Uplift, Texas include a 7-km-thick section of amphibolite-grade, stratified, mafic metasedimentary rocks with interlayers of more felsic composition (Packsaddle Schist). Prior to the end of maximum deformation, the sequence was intruded by syntectonic tonalite (Big Branch Gneiss). At 1167 ± 12 m.y. ago, nearly contemporaneous with the emplacement of the tonalite, small sills of granite (Red Mountain Gneiss) were emplaced adjacent to the tonalite body. The Big Branch Gneiss is characterized by variable Al_2O_3 (14.90–18.14%), Sr (287–873 ppm), Rb (27–71 ppm), and Zr (108–348 ppm) and low Ni (7–25 ppm), Co (17–19 ppm), Cr (18–36 ppm), Sc (8–10 ppm) and K_2O/Na_2O (0.22–0.44); K/Rb ratios range from 274–394. The Big Branch Gneiss has initial $^{87}Sr/^{86}Sr = 0.7038 \pm 0.0002$. Two Big Branch Gneiss samples have La abundances 36–97 times chondritic and exhibit light REE enrichment with $|La/Sm|_N$ from 3.13–4.24 and $|La/Yb|_N$ from 12.40–29.34; neither sample exhibits a significant Eu anomaly. The Red Mountain Gneiss has a fairly uniform granitic composition but extremely variable Rb (127–286 ppm), Sr (17–69 ppm), Y (40–71 ppm), Zr (62–233 ppm), and K/Rb (138–348); Ni is uniform (10–15 ppm). The Red Mountain Gneiss has initial $^{87}Sr/^{86}Sr = 0.7057 \pm 0.0010$.

Major and trace element systematics are consistent with an island arc model in which the Big Branch Gneiss tonalite was generated by ~20% partial melting of basaltic portions of subducted oceanic crust at a depth greater than 55 km, leaving residual eclogite ($\pm$hornblende). The Big Branch Gneiss tonalite was emplaced into the island arc complex where it underwent in situ fractionation of plagioclase and minor hornblende. As the voluminous Big Branch Gneiss magma ascended through the lower portion of the island arc complex, it caused local partial melting of felsic portions of the volcanic and volcaniclastic materials to produce the granitic Red Mountain Gneiss magma, which was subsequently emplaced adjacent to the Big Branch Gneiss pluton. The Red Mountain Gneiss magma underwent a minor amount of in situ fractionation of biotite + quartz $\pm$ alkali feldspar $\pm$ magnetite.