C-O-H isotopes and fluid studies as tools to constrain granulite petrogenesis on Ribeira Fold Belt (SE Brazil)

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This work combines new C-O-H isotopic data with fluid inclusion microthermometry, Raman spectroscopy and fO_2 results in order to constrain fluid and geodynamic evolution of Ribeira Fold Belt (SE Brazil) granulites during the Panafricano – Braziliano Orogeny.

Integration of the data reveals that metamorphic peak fluids evolved under high fO_2 conditions (QFM +1) coeval with fluid inclusion generation of CO_2 and CO_2-N_2 (0 to 11 mol%) high to medium density (1.01 – 0.59 g/cm^3) at T ~ 800 ºC [1] and X_{H2O} < 0.05 [2], whereas metamorphic retrograde (T ~ 600 ºC [1]) low density (0.19-0.29 g/cm^3) CO_2 and CO_2-N_2 (0 to 36 mol%), CO_2 (94 to 95 mol%) – N_2 (3 mol%) – CH_4 (2 to 3 mol%) – H_2O (Flw = 0.1) (in graphitic granulites), N_2 (95 mol%) – CH_4 (5 mol%), H_2O-CO_2 and late H_2O fluids were reduced fO_2 (QFM -1 to -3).

$\delta^{18}O$ quartz results of 10.3 – 10.7‰ imply high-temperature CO_2 $\delta^{18}O$ values of 14.4 to 14.8‰, suggesting the involvement of a metamorphic fluid, whereas lower temperature biotite $\delta^{18}O$ and δD results of 7.5 – 8.5‰ and -54 to -67‰, respectively imply H_2O $\delta^{18}O$ values of 10 to 11‰ and δD_{H2O} of -23 to -36‰, suggesting $\delta^{18}O$ depletion and increasing fluid/rock ratio from metamorphic peak to retrograde conditions. Isotopic results are compatible with low-temperature H_2O influx and fO_2 decrease that promoted graphitic deposition in retrograde granulites, simultaneous with low density CO_2, CO_2-N_2 and CO_2-N_2-CH_4-H_2O fluid inclusions at T = 450 – 330 ºC. Graphite $\delta^{13}C$ results of -10.9 to -11.4, imply CO_2 $\delta^{13}C$ values of -0.8 to -1.3‰ suggesting decarbonation of Cambrian marine carbonates [3] with small admixture of lighter biogenic or mantle derived fluids.

Results suggest that peak fluids were probably ^{18}O enriched metamorphic fluids derived from deep-seated carbonated sources. Rapid pressure and temperature drop during retrograde metamorphism induced fO_2 decrease by fluid admixture with shallower waters, turning peak carbonic fluids into CO_2-H_2O and depleting biotite $\delta^{18}O$ and δD values, and as low-salinity H_2O fluids progressively became dominant, late-graphite deposited at shallower crustal levels.

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