Silicate, oxide, and sulfide trends in granulite-facies neo-Archean rocks from the Nilgiri Block, S India

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The Nilgiri Block, S India represents an exhumed cross section of lower crust that formed through subduction-related orogenic processes and was metamorphosed to amphibolite- to granulite-facies in the Neoarchean (2600-2500 Ma). The northern highlands of the Nilgiri Block are characterized by granulite-facies metagabbros with Pyx-rich enclaves. A two-Pyx granulite transition zone acts as a boundary between the metagabbros and tonalitic-granodioritic charnockites, which comprise the central and southern Nilgiri highlands. The two-Pyx granulite whole rock chemistry suggest that it represents a mix between the original tonalitic-granodioritic granitoids and basaltic melts responsible for the charnockite and the metagabbros, respectively. Gt-Opx thermometry indicates a regional granulite-facies temperature distribution over the Nilgiri highlands of 650 to 800 °C with no obvious trends. Gt-Opx-Plg-Qtz barometry shows some indications of a SW to NE regional trend in granulite-facies pressures from 7 to 11 kbar implying that the metagabbros represent deeper exposed crust compared to the central and southern charnockites.

Regional trends are seen in the oxide-sulfide mineralogy in the granulite-facies rocks. The charnockite is dominated by Rt-Ilm assemblages and Po +/- minor Ccp and pentlandite. Hemo-Ilm-Mt and Py is dominant in the two-Pyx granulite, with co-existing Rt-Ilm and Po in a few samples near the charnockite boundary. In the metagabbros, hemo-Ilm-Mt and Py is dominant. In the two-Pyx granulites and metagabbros, Mt exists as distinct grains, is associated with hemo-Ilm, or exists as oxidation rims around Opx, Cpx, Amph, or Py.

A specific oxidation trend is seen. Metagabbros and two-Pyx granulites from the Nilgiri highlands are highly oxidized compared to the charnockites from the central and southern regions implying that oxidizing agents (possibly as SO_2) were present in fluids (e.g. concentrated brines) during granulite-facies metamorphism of the metagabbros and two-pyroxene granulites. In contrast these agents were more reducing (H_2S) during granulite-facies metamorphism of the charnockites. These trends in the oxygen fugacity across the charnockite, two Pyx granulite, and metagabbro emphasize the potential role of oxidizing and reducing, low a_{H2O} fluids during lower crustal granulite-facies metamorphism in the late Archean.