Incipient “eclogitization” of metagranitoids at closed-system conditions

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The incipient development of diagnostic high-pressure assemblages – the “eclogitization” – of granitoids, such as plagioclase-breakdown and small-scale formation of garnet and phengite does not require exogenous hydration because unlike dry protoliths like basalt/gabbro or granulite, granitoids s.l. contain crystallographically-bound H_2O in biotite. During high-pressure overprint, partial biotite breakdown causes a localized increase in the chemical potential of H_2O (μH_2O). Transport of H_2O into nearby plagioclase induces the formation of diagnostic eclogite-facies assemblages of jadeite–zoisite–K-feldspar–quartz ± kyanite ± phengite that pervasively replace former cm-sized plagioclase without requiring the participation of free H_2O. Depending on pressure–temperature evolution, similar textures may involve albite instead of jadeite, consistent with the general absence of Na-clinopyroxene in high-pressure metagranitoids and kindred gneisses. Plagioclase-breakdown may also occur due to simple burial because compression leads to an increase of μH_2O, without requiring additional influx of H_2O at the texture scale. However, the addition of biotite-derived H_2O into plagioclase sites likely increases reaction rates. In parallel, ~100 µm-thick complementary coronae involving garnet | phengite–quartz develop at former biotite–plagioclase/K-feldspar interfaces due to the coupled diffusion of FeO–MgO–H_2O from biotite towards feldspars, and minor CaO in the opposite direction. The reaction textures likely create structural weaknesses and preferential fluid pathways that facilitate further hydration and/or deformation along the prograde path, thereby obliterating of the textures. If exogenous H_2O is introduced, it is accommodated in phengite growing at the expense of igneous K-feldspar and possibly in epidote-group minerals. Upon decompression, such hydrated rocks would dehydrate, thereby favouring fluid-assisted retrogression and loss of diagnostic eclogite-facies assemblages at lower pressure. Whereas the prograde reaction textures are only preserved at closed-system conditions and in the absence of deformation, they are suggested to commonly form during orogenic metamorphism of granitoids and quartzofeldspathic gneisses that dominate the continental crust in high-pressure terranes such as the Western Italian Alps and the Western Gneiss Region (Norway).