Epitaxy is the Sincerest Form of Replacement

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Gold deposits are often the loci of multiple generations of fluid flow. Changing bulk rock and fluid compositions lead to a progressively changing assemblage of stable minerals. This paragenetic evolution is often accomplished by epitaxial replacement of one phase by another. In the Junction Deposit, Western Australia, the metamorphic albite-actinolite-chlorite greenstone assemblage has been replaced, during early-stage K-CO_2-S metasomatism, by calcite and biotite with sulphidation of igneous magnetite. Detailed petrography shows that gold is associated with a second stage of replacement where biotite breaks down to muscovite and chlorite. Calcite is replaced by heterogeneous nucleation of siderite and dolomite along twin planes. We demonstrate that, despite apparent open space growth textures, dolomite grew by solid state replacement of the calcite. Nucleation was localised on chemical heterogeneities within the calcite taking advantage of lattice strain around Fe-enriched calcite patches.

Elsewhere in the same sample, ilmenite is breaking down to anatase and rutile during the siderite/dolomite forming event. Despite lack of crystallographic correspondence between Ti-bearing phases, the dolomite that infills porosity generated during the reaction has nucleated epitaxially on the relic ilmenite. This highlights the potential importance of surface processes during metamorphic and alteration reactions. Finally, gold is mineralised in zones of biotite breakdown to muscovite. Detailed analysis of the mica and gold crystallogrpahy shows that the distribution of gold orientations is not statitically random. The orientations of gold {111} planes is subparallel to that of the mica (001) planes as is observed during industrial chemical vapour deposition processes. This highlights the utility of examining gold crystallography to understand fully deposition mechansims in gold deposits. Whilst the previous examples show that surface processes are important for undrestanding mineral reactions, the localisation of gold mineralisation on mica highlghts the economic importance of understanding the role of surface chemistry processes in the crust.