

HYDROTHERMAL CLAY MINERALS IN GRANODIORITE OF THE MAIN TERRACE, STEAMBOAT SPRINGS, NEVADA*

by

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EXTENDED ABSTRACT

HOT SPRING waters at Steamboat Springs, Nevada, are depositing small amounts of mercury, antimony, gold and silver, and have hydrothermally altered the rocks through which they flow. Two patterns of alteration can be recognized in the granodiorite bedrock underlying the Main Terrace: an ill-defined pattern of alteration related to depth and a more distinct pattern consisting of zones of various mineral assemblages enveloping fractures.

The zones of alteration related to fractures consist of a sericitic zone adjacent to fractures and an argillic zone farther from the fractures. The mineral assemblages of these zones resemble the alteration mineral assemblages in granodiorite of the Butte, Montana, copper mining district.

In the argillic zone, hornblende is the most reactive mineral and is replaced by random mixed-layer illite-montmorillonite and iron-rich chlorite. Biotite alters pseudomorphically to chlorite. Calcic plagioclase in general alters to random mixed-layer illite-montmorillonite. Quartz and orthoclase are unaltered in the argillic zone.

In the intensely altered sericitic zone, only illite, quartz and pyrite appear to be stable. The random mixed-layer illite-montmorillonite formed in the argillic zone changes to illite with less than 10 per cent interlayered montmorillonite in the sericitic zone. Plagioclase and orthoclase also alter to illite. Chlorite is replaced by pyrite and a coarse-grained white mica that is probably chemically similar to the illite. Chalcedonic silica forms as a result of the breakdown of silicate minerals.

Away from fractures in the argillic zone, the alteration mineral assemblages are influenced by depth. Below 200 ft, albite and calcite replace the cores of some plagioclase crystals, along with formation of random mixed-layer illite-montmorillonite. At depths shallower than 300 ft some plagioclase is replaced by hydrothermal K-feldspar again with formation of mixed-layer clay.

Close to fractures, the intense alteration of the sericitic zone encroaches upon and progressively replaces the alteration minerals of the less intense argillic zone as well as the alteration minerals related to depth.

Illite from the altered rocks is of clay size and has a 10 Å periodicity that is unaffected by glycolation or heating to 550°C for 1 hr. It is therefore interpreted to contain less than 10 per cent expansible layers.

The random mixed-layer illite-montmorillonite contains up to 45 per cent montmorillonite layers. The nonintegral series of X-ray peaks from this mixed-layer clay includes a peak at about 30 Å.

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The deep high-temperature waters at Steamboat Springs alter the original minerals in the granodiorite to yield illite, quartz and pyrite as apparently stable phases. Calculation of the $K^+ : H^+$ molal ratio in the deep water for comparison with Hemley's reaction studies in the KCl-HCl system indicates that the water has a composition in which illite is stable.

Apparently the present-day thermal waters, in addition to depositing metals, are producing the observed hydrothermal alteration and, therefore, may be similar to fluids that have formed some ore deposits.

REFERENCE

- SCHOEN, ROBERT and White, D. E. (1965) Hydrothermal alteration in GS-3 GS-4 drill holes, Main Terrace, Steamboat Springs, Nevada: *Econ. Geology* (in press).