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Title: ALKALINE EPITHERMAL SYSTEMS IN NORTH AMERICA:
CHARACTERISTICS, DIVERSITY, ORIGINS, AND
OPPORTUNITIES

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Abstract: Epithermal Au deposits related to alkaline magmatism constitute a major and distinctive class of epithermal deposits. Exploration for them continues on a global scale due to their size (several examples with >25 Moz Au), environmentally favorable geochemical characteristics (low acid-producing potential), and a legacy of spectacularly high-grade mineralization (large tonnages at >0.5opt). In spite of their grade and size, their expressions are commonly subtle due to a relative lack of quartz veining and pyrite-rich acid alteration. Work over the past decade in North America has revealed systematic relationships and provides new insight into how these deposits form, and what distinguishes them from the broader class of epithermal deposits.

The most significant of these deposits in North America are the Tertiary alkaline epithermal districts of northern and central Rocky Mountains (central Montana, Black Hills, and Colorado Front Range). To the extent documented, Au is commonly present as tellurides and is intimately associated with intense K-alteration of host rocks. Hydrothermal quartz typically hosts Au minerals, but is sparse; veins tend to be narrow and deposits are quartz-poor compared with other epithermal deposit types. Accessory minerals include fluorite, barite, REE phases and abundant CO₃ +/- SO₄. Gross similarities in styles and chemistry of mineralization and alteration argue for links to common genetic processes controlled by the bulk chemistry of the alkaline igneous systems and derivative hydrothermal solutions. These deposits may also be exceptional for epithermal systems in that ore deposition appears to be dominated by magmatic fluids.

Other distinctive styles of mineralization are seen in mid-Tertiary alkaline intrusive complexes of New Mexico; these include systems with abundant Fe-oxide, Ca-silicates and/or scapolite, which more closely resemble styles seen in IOCG systems. These reflect genetic processes that are distinct from the other alkaline systems and likely represent the influx of external saline brines into the hydrothermal system.

Like other deposit types, distinguishing economic systems from others can be challenging. Alteration in both can be cosmetically similar at macroscopic scales, but key distinctions appear to be intense K + pyrite/CO₃ alteration of host rocks in the large economic systems, vs. significant zones of pyrite/CO₃ alteration without significant K-addition in barren or weakly mineralized systems.

In several examples zones of alteration dwarf zones of economic mineralization, and many systems show evidence for multiple hydrothermal centers through time and space. Further, alkaline epithermal systems may be juxtaposed or developed in close proximity with other mineralization types, including those produced by external fluids (e.g. IOCG-types) and base metal-rich “porphyry” types. Thus, careful system-scale mapping and consideration of multiple models are essential for exploration in individual systems.