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Role of slab bending in the epithermal gold mineralization of South Kyushu, Japan

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Tectonic settings play a first order control in the development of ore-forming systems, primarily because they influence both the structure of the system (e.g., transport conduit and trap) and the nature of the magmas and fluids involved (e.g., system longevity and element budgets). Consequently, understanding these settings and their geological evolution is critical for predicting and identifying styles of mineralization and their spatial extent. The Hishikari low-sulfidation epithermal deposit in South Kyushu, Japan, is a large-scale gold deposit (>250 t Au) in with one of the highest gold grade in the world (ave. 40g/t Au). The deposit is hosted in a basement uplift structure underlain by a positive gravity anomaly that is interpreted to represent the ore-forming intrusion and associated fracture systems. Although gravity data and drilling record from the region suggests that such transport-trap structures are common, gold production records demonstrate that mineralization in the region is rare and sporadically distributed. It remains unclear which processes contribute to the extremely variable endowments in the area.

Using compiled and new geochemical data for volcanic rocks in South Kyushu, we show that the across-arc, mildly calc-alkaline volcanic activity in the Early Quaternary (2.5-1.6 Ma) was spatially confined to narrower areas in the volcanic front and the back-arc in Middle Quaternary (1.6-0.5 Ma). This is probably linked to slab bending associated with asthenosphere inflow into the mantle wedge, which initiated around 2 Ma. As a result of the change in stress regime, the Middle Quaternary volcanic activity became relatively long-lived, more calc-alkaline and felsic in composition in the volcanic front, with short-lived, tholeiitic and mafic activity dominating in the back-arc. The apparent gold endowment in each setting, which is moderate (<50t Au) in the Early Quaternary, high in the Middle Quaternary volcanic front (e.g., Hishikari), and low (<10t Au) in the Middle Quaternary back-arc, roughly correlates with the duration of magmatic-hydrothermal activity and inferred water content from the tholeiite index. Hence, longevity and magma chemistry of the system, coupled to a change in the tectonic regime, appear to be critical for the formation of large gold deposits in the region.