ST.223

Reconstructing the Geometry and Tectonic Setting of Mid to Late Cretaceous Porphyry Formation in Eastern Interior Alaska

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Understanding the original, regional geometry of Mesozoic magmatic belts in Alaska is a critical component for interpreting the tectonic setting in which porphyry deposits formed. Hundreds of kilometers of Cenozoic strike-slip separation along major faults has substantially disrupted or obscured possible tectonic connections between terranes, overlap assemblages, and regional igneous suites. Here we consider a geological reconstruction that restores ~400 km of dextral separation on the Denali fault. The restored Cretaceous geometry places the Talkeetna Mountains (presently in south-central Alaska) directly south of the Yukon-Tanana upland (presently in eastern interior Alaska), bringing regionally extensive Mesozoic magmatic belts into better alignment and providing a framework for interpreting geochemical, isotopic, and metallogenic patterns in a spatially realistic framework.

Early and middle Cretaceous magmatism (~135-90 Ma) occurred along the entire northwestern Cordillera margin. In our reconstructed geometry, rocks of this age range define a ~1,000-kilometer arcuate belt in Alaska from the Alaska-Aleutian Range batholith in southwest Alaska to the Yukon border, with a magmatic gap across the Talkeetna Mountains. This plutonic suite has been interpreted to record arc magmatism above a moderately to steeply dipping subduction margin. Additional mid-Cretaceous collisional intrusive suites are emplaced inboard of the Circum-Pacific subduction margin define a 40- to 100-km-wide belt across the Yukon-Tanana upland in eastern Alaska. These rocks are characterized by crustal Sr and Nd isotope ratios and elevated U/Yb relative to Nb/Yb in zircon. Collisional intrusive suites are interpreted to have been emplaced during regional orogen-parallel extension in the thickened back arc and record collapse of a Jurassic-Cretaceous orogenic wedge. Between ~90 and 80 Ma, subduction configuration changed, shifting magmatism further inboard (modern-day north) into the mid-Cretaceous back arc. Late Cretaceous arc magmas overlap in space with the collisional mid-Cretaceous crustal granites in the Yukon-Tanana upland and are expressed as a swath of shallowly emplaced dikes, stocks, and dike swarms and coeval volcanic rocks in a broadly NW-SE belt extending into western Yukon. Arc plutons are characterized by distinctly more juvenile Sr and Nd isotope ratios and lower U/Yb relative to Nb/Yb in zircon compared with the collisional plutons.

Porphyry systems formed throughout the duration of Cretaceous magmatism in eastern Alaska. However, the most prolific porphyry formation (e.g., Pebble, Orange Hill, Bond Creek) occurred in association with arc magmatism in districts southeast and southwest of the Yukon-Tanana upland. In contrast, porphyry Mo systems with local W-rich skarn occurrences are more prevalent in the Yukon-Tanana upland in association with collisional mid-Cretaceous granites. Late Cretaceous porphyry systems in the upland and in western Yukon are associated with the inboard calc-alkaline granodiorite to monzonitic intrusions and consist of porphyry Cu-Mo deposits with variable Au enrichments. In eastern Alaska, inferred changes in the geometry of the subduction interface are interpreted to have controlled spatial and temporal variations in the distribution and style of porphyry systems along and across the strike of the margin.