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THE UPPER PALEOZOIC GOLCONDA TERRANE, WESTERN UNITED STATES: THE REMNANTS OF A BACK-ARC BASIN ACCRETED BY NON-COLLISIONAL PROCESSES.

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The Western United States Cordillera and South American Andes have a similar two stage evolution in which the Paleozoic and Early Mesozoic history is characterized by "collision" of oceanic terranes such as island arcs and the remnants of oceanic basins, and a late Mesozoic and Cenozoic stage characterized by construction of continental volcanic arcs over the older accreted terranes. This two stage history is frequently thought to represent the operation of fundamentally different processes during the different stages; collisional processes during the early stage, and non-collisional, largely subduction-related processes during the later stage. Proper interpretation of the processes operating depends on identification of the paleogeography and tectonic setting of the different tectonostratigraphic elements involved. A frequent problem in interpreting the paleotectonic setting, where oceanic terranes are involved, is identifying the facing-direction of island arcs and distinguishing between collapsed back-arc basins and the remnants of open ocean basins telescoped into subduction-zone accretionary prisms. Recent detailed work in the Golconda terrane of the western United States (Fig.1) indicates it represents the remnants of a collapsed back-arc basin that was accreted to the margin by non-collisional processes indicating the early history of the western U.S. was not entirely a result of collisional processes.

The Golconda terrane was accreted to the western North American margin during the mid-Permian to Early Triassic Sonoma orogeny. The orogeny is frequently viewed as an arc-continent "collision," with the Golconda terrane, a structural complex consisting of oceanic sediments and basaltic volcanic rocks, representing the structurally telescoped remnants of an oceanic basin (Havallah basin) which once separated the volcanic arc (Paleozoic Klamath-Sierran arc, Fig. 1) from the North American continent. Detailed mapping with structural, biostratigraphic, and petrologic studies

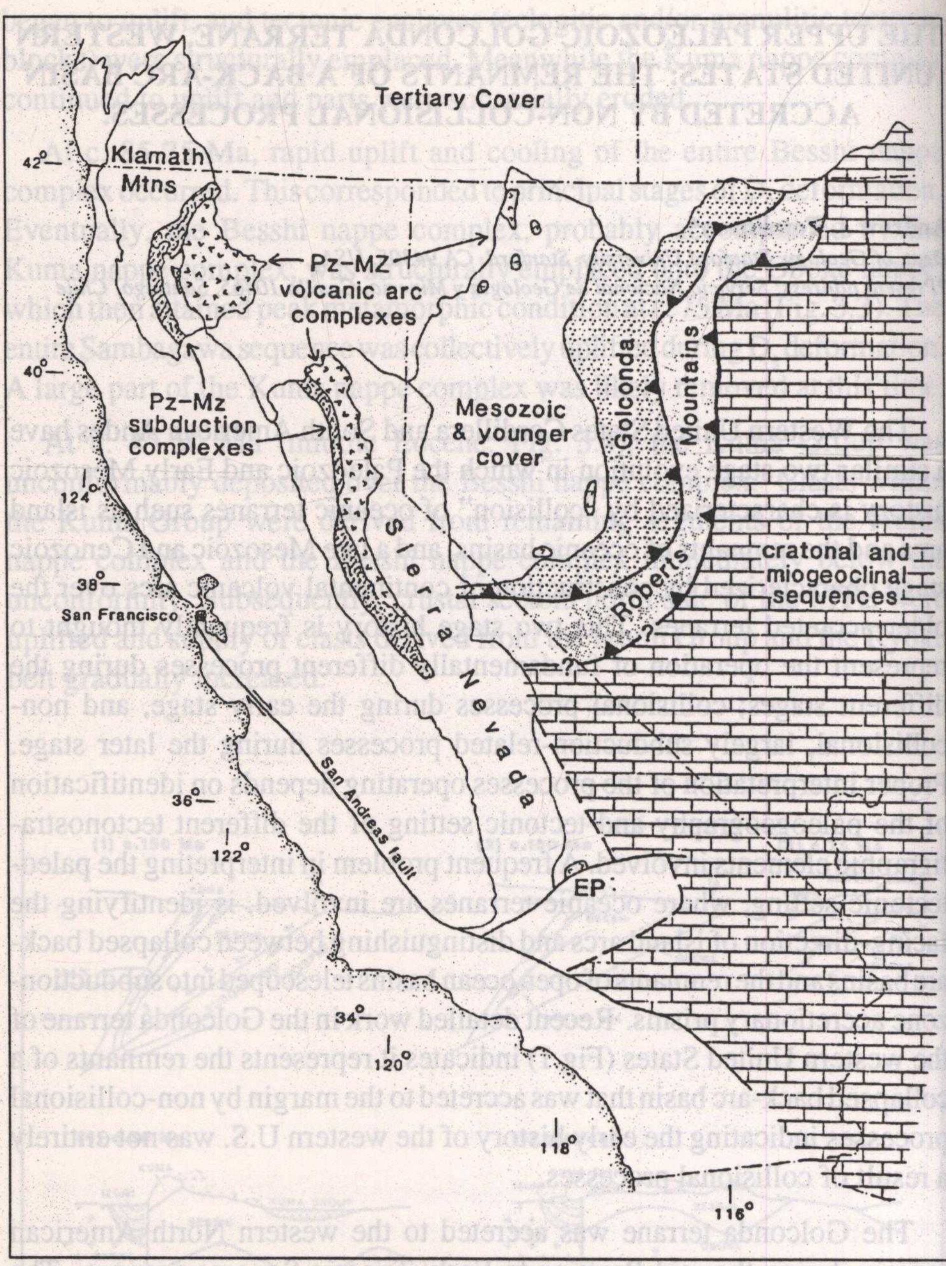

Figure 1: Map of southwestern U.S. showing the major Paleozoic lithologic and tectonic elements.

in the structural complex permit a reconstruction of the basins paleogeography and tectonic history prior to and leading up to the "collisional" event.

The sediments in the structurally lowest thrust plates in the terrane, and least traveled with respect to the margin, include argillite, radiolarian and spiculitic chert, basalts, and siliciclastic and calcarenitic turbidites. The petrography and age of the clastic rocks is similar to depositional events on the continental margin. These include 1) mid-Mississippian through mid-Permian quartzose, chert- and sedimentary-lithic rich, sandstones and sandy calcarenites similar in composition and age to the clastics of the Antler sequence deposited on the margin, 2) Lower Permian monocrystalline quartz-rich, sandy calcarenites and calcareous sandstones similar in composition and age to the Arcturus Group deposited on the margin, and 3) mid-Permian phosphatic quartzose sandstones similar in composition and age to the Edna Mountain and Phosphoria Formations. In addition, the Lower Permian monocrystalline quartz-rich, sandy calcarenites and calcareous sandstones contain fusulinid bioclasts which have a North American paleobiogeographic affinity (Calvin H. Stevens, written commun. 1986). The data indicate that the sequences composing the structurally lowest thrust sheets were deposited adjacent to the continental margin.

The structurally highest thrust plates of the terrane, and farthest traveled with respect to the margin, contain argillite, radiolarian chert, basalts, and volcaniclastic sandstones and conglomerates. Age data indicate volcaniclastic deposition was intermittent from the Late Mississippian through Early Permian (?) time with widespread volcaniclastic deposition occurring in the mid-Permian. Petrography and K-Ar ages on detrital grains reported by Speed (1977) indicate the mid-Permian volcaniclastic rocks are derived from a largely undissected, penecontemporaneous volcanic source. Comparison of the arenites to compositional fields for modern arc-derived sands indicate the arenites are most comparable to sands derived from undissected arcs constructed on microcontinental plates or fragments of continental material. Construction of the source arc terrane on continental material, or at least on sediments derived from a continent, is supported by U-Pb isotopic data on zircons extracted from a granodiorite boulder. The isotopic data indicate an Early Permian 264±4 Ma crystallization age for the granodiorite and the presence of an inherited or xenocrystic zircon component of approximately 2.2 Ga (isotopic analyses by J.E. Wright). The provenance, age of deposition, and isotopic data are compatible with the volcaniclastic sediments being derived from the Klamath-Sierran arc in California or its equivalents.

Knowing the structural stacking order of the thrust plates, their paleogeographic affinity, and the direction of thrusting (west over east), the basin and its tectonic history can be reconstructed in a general fashion. A synthesis of the data obtained in this study, together with previously published work in other parts of the terrane indicate the following: 1) a mid-Mississippian rift opening of the basin between the continental margin and a volcanic arc that had earlier "collided" with the margin during the mid-Paleozoic Antler orogeny (Miller and others, in press), 2) a period of *relative* stability spanning the Late Mississippian to Early Permian, during which, the eastern side of the basin received sediment from the continental margin and the western side of the basin received material, at least, intermittently from a volcanic source, 3) a closure history, beginning in the mid-Permian, that was characterized by widespread deposition of volcaniclastic rocks synchronous with a pulse of volcanism in the Klamath-Sierran arc and deformation in the continental margin in east-central California, where the basin likely narrowed with the arc in close proximity to the continental margin.

The history of the Havallah basin has strong similarities to the Neogene history of the Sea of Japan back-arc basin. These similarities include a rift opening of the basin and an early closure history characterized by deposition of volcaniclastic rocks synchronous with a pulse of volcanism in the Japan island arc, deformation in the Asian continental margin, between Korea and Japan, where the basin narrows, and development of a back-arc fold-and-thrust belt behind the Japan island arc which is currently accommodating convergence between Japan and Asia.. This analogy supports a back-arc basin model for the evolution of the Havallah basin. The lack of evidence for a Permian-Triassic collisional event against the western margin of the Klamath-Sierran arc, and instead, some evidence for Permian-Triassic subduction west of the arc synchronous with the Sonoma orogeny, suggests non-collisional plate boundary processes provided the driving forces for the Sonoma orogeny in the back-arc region.

The geology indicates that non-collisional, subduction-related processes were also active during at least part of the Paleozoic "oceanic" history of the western U.S. Where blueschist metamorphic facies are absent, subduction zone accretionary prisms are frequently identified based on their structural style and lithologic content. The similarity in structural style, and in general lithologic content, of the Golconda terrane to subduction-zone accretionary prisms emphasizes the difficulty in distinguishing collapsed back-arc basins from accretionary prisms. In mountain belts, the preservation potential for back-arc basins should be greater since they are frequently positioned between a continent and a destructive plate boundary. Shortening in the overriding plate, driven by processes at the plate boundary as the result of changes in convergence velocity or the thermal structure of the down-going slab, will likely take place in the back-arc region and result in the preservation of some back-arc materials by thrusting onto the adjacent continent or island arc. In the case of accretionary prisms, their position at the destructive plate boundary gives them a greater potential for being removed by processes such as subduction erosion and margin-parallel transcurrent faulting. It is suggested that other terranes in the circum-Pacific similar to the Golconda terrane may be collapsed back-arc basins accreted to their adjacent continents by non-collisional processes. In conclusion, a view that the Paleozoic tectonic evolution of the western U.S. is the result of collisional processes is an erroneous one based on a misinterpretation of the tectonic settings represented by the different terranes.

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