GEOLOGY OF THE MAZATZAL MOUNTAINS, CENTRAL ARIZONA

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INTRODUCTION

The Arizona Project was based in the Mazatzal Mountains and surrounding area. The group was based in Rye, about 12 miles south of Payson; and field sites were in the Mazatzal Mountains, at Tonto Natural Bridge, and on the alluvial fan sediments between the Mazatzal Mountains and the Sierra Ancha (Figure 1). The area has a long and diverse geologic history that fueled a diverse set of junior projects. The Mazatzal Group is a series of quartzites, pelites, and associated rhyolitic flows and tuffs that were deposited in the waning stages of a major amalgamation of terranes and juvenile crustal material that formed the real estate of the southwestern United States, about between 1.7 and 1.65 Ga ago (Karlstrom and Bowring, 1991). These supracrustal rocks were deformed into a series of thrust sheets during the Mazatzal Orogeny at about 1.65 Ga. The Mazatzal Mountains as a physiographic feature were uplifted in the Tertiary, and are surrounded by an apron of alluvial fan deposits that were produced in Pliocene and Pleistocene time, when the range-bounding faults were active .

Some students in the Arizona Project undertook sedimentologic and structural analysis of the Mazatzal Group to address questions about the tectonic setting in which the sediments were deposited; others looked at the young alluvial fan sediments in order to understand the unroofing history of the Proterozoic basement.

Our work was facilitated by the detailed structural mapping of Karl Karlstrom and his students eg. (Doe and Karlstrom, 1991; Puls and Karlstrom, 1991). Our group worked largely from the map of Doe (1991), which was drafted onto a topographic basemap and colour-coded by Ethan Gutmann, research assistant and camp quartermaster for the Arizona Project.

GEOLOGIC SETTING

Proterozoic rocks in central Arizona record the accretion and assembly of continental crust between 1.8 and 1.6 Ga. The Proterozoic orogenic belt can be divided into tectonic blocks with differing stratigraphies and structural histories, possibly assembled in a series of discrete docking events (Karlstrom and Bowring, 1988). Work done in this area during the last decade has greatly furthered our understanding of the growth and evolution of Proterozoic North America, but many questions about the accretionary events remain. In particular, the nature of the accreted blocks is, in many cases, still unclear: debate continues as to whether they were island arcs, continental arcs, or microcontinents. This unresolved question has implications not only for the tectonic history of North America, but also for our understanding of the growth of continental masses throughout earth history.

Sedimentologic analysis is a tool that may help answer some of these questions. It is one that has been underused in studies of Precambrian rocks in the southwest, largely because of the deformation and metamorphism that the rocks have undergone. The structural and metamorphic studies of recent years, however, have provided a solid framework and fundamental understanding of the tectonic evolution of the area, and so the time is ripe to look at the sedimentary sequences from a process sedimentology perspective.

Detailed mapping of fine-scale structural features is another tool that can provide insights into the tectonic history of these rocks. The relationship of the thrusting in the Mazatzal Group rocks to deformation in higher-grade rocks of the surrounding area is currently debated eg. (Doe and Karlstrom, 1991; Wessels and Karlstrom, 1991). Looking at the orientations of pervasive features such as quartz veins is a way of understanding the mechanics of thrust-sheet movement, and provides criteria for use in future studies comparing deformation styles in the Mazatzal Mountains and the surrounding area.

In the Tertiary, fault movements exhumed the Proterozoic supracrustal sequence, and coarse clastic sediments were shed into the Tonto Basin where they accumulated as alluvial fans. These largely unlithified deposits have been little studied, but they have a story to tell about the recent tectonic development of the Mazatzal region.

PROJECTS

The students worked on two structural projects and five sedimentology projects on the Proterozoic rocks, and two sedimentology projects on the alluvial fan sediments. The combination of detailed sedimentology and petrographic provenance analysis and geochronology should provide a synthetic understanding of the tectonic setting and depositional history of the Mazatzal Mountains, which will contribute to a better understanding of the tectonic history of central Arizona.

Martin Wong (Williams College) and David Schneider (Carleton College) worked on strain analysis in the Mazatzal Group, using the geometry and distribution of quartz veins as indicators of the stress fields during the 1.65 Ga deformation event. Martin concentrated on veins in the quartzite units, and David worked on the pelitic rocks. Their work is a contribution to the understanding of the complex deformation history of the Mazatzal Mountains area and shows how the orientations of both the veins and their constituent fibres can be used to model the response of these rocks to stress during thrusting and folding.

Four students carried out detailed sedimentological analysis of the formations within the Mazatzal Group. Laura Dickerson (Colorado College) and Karrie Karpinski (the College of Wooster) examined the lower and upper members of the Deadman Quartzite. James Sammons (Washington and Lee University) studied the Maverick Shale. Ingrid Ekstrom (Amherst College), looked at the transition between the Maverick Shale and the Mazatzal Peak Quartzite. These studies, based on section measuring in the field and thin-section work at their respective colleges, represent the most detailed and comprehensive sedimentologic analysis yet undertaken of these rocks, and should significantly improve our understanding of depositional environments and facies changes in the Mazatzal Group.

Jana Comstock (Williams College) focused on the provenance of quartzites in the Mazatzal Group. Interpretation of the Mazatzal Quartzite and related units as quartz arenites has always been problematic because the interbedded rhyolites indicate deposition in a tectonically active setting. The association of compositionally mature sediments and volcanic rocks is not known from any recent or modern setting. Her results show that these sediments were in fact deposited as lithic-rich sandstones, and that their apparent compositional maturity is the result of diagenetic alteration of labile grains. In addition, she is using U-Pb geochronology to date rhyolites at localities in the Mazatzal Mountains and several miles away, at Tonto Natural Bridge, to see if we can make a stratigraphic correlation between the Deadman Quartzite and similar, unnamed quartzites at Tonto Natural Bridge.

Nick Lang (Whitman College) and Katy Werner (Carleton College) studied the sedimentology and facies architecture of the alluvial fan sediments in the Mazatzal Mountains region. Their work will contribute to regional correlation of alluvial deposits in the wider Tonto Basin area. In addition to detailed field measurements, they have used aerial photograph interpretation to map out different fans and relate them to the drainage history. Analysis of paleosols that formed at various times as the fans were being built provide information about the rates and timing of fan construction, which in turn is related to the neotectonic uplift history of the region.

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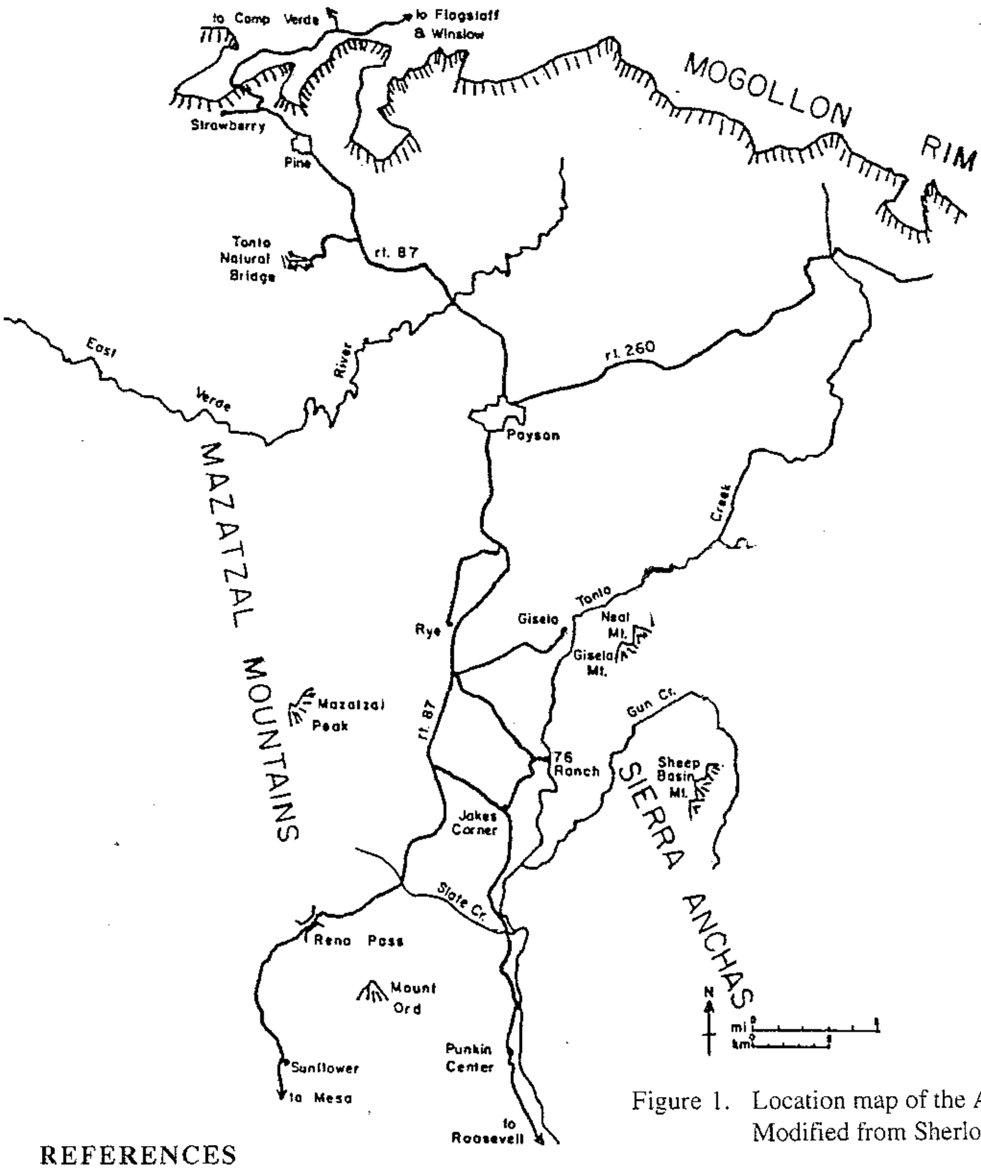

Figure 1. Location map of the Arizona Project study area. Modified from Sherlock and Karlstrom (1991)

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