Petrological and geochronological analyses of the Mazatazal Quartzite and related units from central Arizona.

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INTRODUCTION

This project is a petrographic and geochronologic study of the Mazatzal Group and related rocks in central Arizona. The Mazatzal Group consists of the Deadman Quartzite, Maverick Shale, and Mazatzal Quartzite, and overlies the Red Rock Rhyolite. Outcrops of similar quartzite units and underlying and interbedded rhyolites occur at Tonto Bridge. The Del Rio Quartzite, which outcrops in Paulden, Arizona, is similar in bedding and deformation to the Mazatzal Group Quartzites. These units have been tentatively correlated, but the stratigraphic relations are not confirmed.

Previous work has interpreted the Mazatzal Quartzite, the Deadman Quartzite, the Del Rio Quartzite, and related quartzites as pure quartz arenites (Trevena, 1979; Bayne, 1987). However, Dickinson's (1985) QFL analysis of sandstone composition correlates quartz arenites with stable craton deposition. While the tectonic setting of central Arizona at 1.7 Ga may be debated, all interpretations show that it was tectonically active. There is no modern analog for deposition of pure quartz arenites in a tectonically active setting, and for this reason, the Mazatzal Quartzite has never been fully understood. Therefore this study tests the hypothesis that quartzites of the Mazatzal Group were deposited as immature sediments, and that diagenetic processes have skewed their provenance interpretation. To this end, I have used a combination of petrographic and chemical data to reconstruct a normative depositional mineralogy. The reconstructed composition yields provenance information that is more appropriate to the active tectonic setting in which these rockas are known to have been deposited.

The second part of this study will examine the proposed stratigraphic correlation between two rhyolitic layers which are interbedded with these quartzites. The Red Rock Rhyolite has been dated by Conway (1976) at 1.715 Ga $\pm$ 15 my and by Karlstrom and Bowring (1991) at 1.71-1.70 Ga. Bayne (1987) described a rhyolitic layer interbedded with the Deadman quartzite at Tonto Bridge. Doe (1991) examined the Red Rock Rhyolite as well as the rhyolite found between the Upper and Lower Deadman, and he tentatively correlated the layer found at Shake Tree Canyon with the layer found at Tonto Natural Bridge. The geochronology section of this project will test that hypothesis by procuring dates for the two rhyolites.

METHODS

Seventy-seven samples were taken from the Mazatzal Mountains, Tonto Natural Bridge State Park, and Paulden, Arizona. Sampling sites within the Mazatzal Mountains include Shake Tree Canyon, Barnhardt Canyon, and North Peak. Samples were taken from both the Upper and Lower members of the Deadman Quartzite, both the red and white members of the Mazatzal Quartzite, and the Del Rio Quartzite. These sandstones represent water-lain current-worked deposits: all exhibit traction structures and are well-sorted with well-rounded grains.

Fifty one of these samples were slabbed and thin sectioned for point counting. Thirty six of these were point counted. Thin sections were point counted using a modified Gazzi-Dickinson method (Coxe and Lowe, 1996), whereby data was recorded for points within framework grains of diameter 0.2-0.6 mm as well as for matrix. Amount and type of matrix and cement were also recorded. Data reported in Cox and Lowe (1996) were also included in the analysis.

Eleven of the samples from all sites and all units were crushed for whole rock major element analysis. The results from this chemical analysis were combined with petrographic data to construct a normative depositional mineralogy for the sandstones using the methodology of Coxe and Lowe (1996). The chemical constituents accounted for by point counted framework grains were subtracted from the oxides listed in the chemical analysis data, and mineralogy was then calculated from the remaining oxides. The resulting minerals were used as a guide to assign secondary matrix an origin as either feldspars or lithics, and these reconstructed primary mineralogies were plotted on a Dickinson (1985) QFL diagram.

For geochronologic analysis, both the Red Rock Rhyolite and rhyolitic layer within the overlying quartzite were sampled at Tonto Natural Bridge. In addition, a sample was taken from the rhyolitic layer found interbedded with the Deadman Quartzite at Shake Tree Canyon. These samples were crushed using a sledgehammer, jawcrusher and discmill. Once the samples were reduced to powder, heavy minerals were removed by running the sample over a wet table. Heavy liquids were used to sort the denser grains on the basis of specific gravity. The remaining sample was sorted by a magnetic separator, and zircons were handpicked for U-Pb dating. Results are still pending.

A number of factors make zircon dating difficult for these rhyolites and may be possible sources of error. The zircons found in these rhyolites are very small (< .5 mm diam) and are difficult to separate out of the sample. Further, once zircons have been separated, determining their ages may be complicated, as some of these grains may have been subject to inheritance or thermal resetting.

PROVENANCE ANALYSIS OF QUARTZITES

Effects of Diagenetic Processes in Sandstones

Provenance analysis of ancient sandstones is complicated by the diagenetic alteration of feldspars and lithic fragments to pseudomatrix (e.g., Dickinson, 1970; Cox and Lowe, 1996). Such alteration of framework grains may result in apparent compositions for ancient sandstones that are more mature than their depositional compositions. Since standard point counts only analyze framework grains and either ignore matrix or exclude samples with large amounts of secondary matrix, feldspars and lithics are underrepresented in QFL interpretation of diagenetically altered sandstones. Thus standard methods for reconstructing provenance and tectonic setting (Dickinson, 1970; Dickinson, 1985) may yield skewed or inaccurate results (Cox and Lowe, 1996). Therefore this study uses a joint approach, combining the methods introduced by Coxe and Lowe to point count and reconstruct normative depositional mineralogies with Dickinson's method of using a QFL diagram to interpret tectonic setting.

Secondary Matrix in Mazatzal Quartzite

The grain size, degree of sorting, and abundance of subaqueous traction structures, such as trough cross bedding, tabular cross bedding, and ripples, indicate that these quartzites were waterlain. Sandstones deposited in shallow water generally have less than 5% depositional matrix (Visher, 1969). Thus, if these sandstones have significantly higher amounts of matrix and framework grains are well-sorted, it can be inferred that much of this matrix is secondary. Since the framework grains that were converted into matrix are no longer available for point counting, production of pseudomatrix introduces a significant source of error into provenance analysis through petrographic study.

Discussion and Conclusions

The amount of matrix in the thin sections is considerably higher than is expected in a waterlain sandstone (Fig 1). Percentages range from zero pecent to thirty eight percent, with the median at 15-20%. Thus we may assume that most of these samples contain secondary matrix, and some samples contain as much as thirthy percent secondary matrix. Framework grains are primarily quartz, but interstitial material includes considerable amounts of sericite, iron oxide, and micas.

Using the traditional method of plotting only framework grains on the Dickinson QFL diagram (fig 1), these quartzites lie almost directly on the quartz pole. They are classified as pure quartz arenites and are assigned a stable craton depositional environment.

However, the matrix in these quartzites is secondary, and indicates the presence of framework grains that are no longer recognizable. Figure 3 shows the raw point count data for the eleven samples with available chemical anaylsis data. The normative depositional mineralogies for these eleven samples have been plotted in figure 4. The adjusted values for these samples now fall in the recycled orogen field on a Dickinson (1985) QFL plot. This new provenance interpretation allows us to make a contribution to the debate on tectonic setting. The lithic clasts we find within these samples are, for the most part, rhyolitic volcanics or sedimentary. Mafic volcanics are absent, which argues against an arc-related setting. Furthermore, feldspars are almost exclusively k-feldspar, not plagioclase. The recycled orogen interpretation, combined with the predominance of rhyolitic volcanic clasts and k-feldsapar, and the dearth of mafic volcanic clasts and plagioclase, suggest that this region has a continental origin.

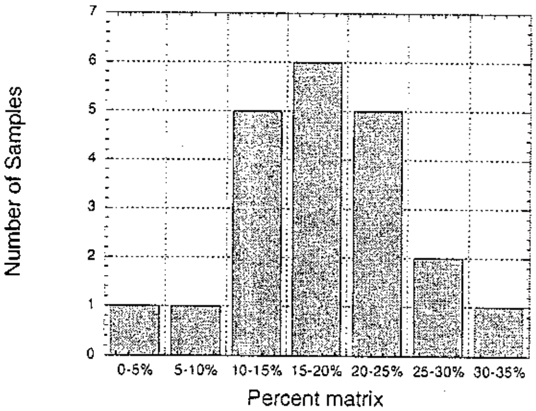


Figure 1. Matrix in Mazatzal Group Quartzites

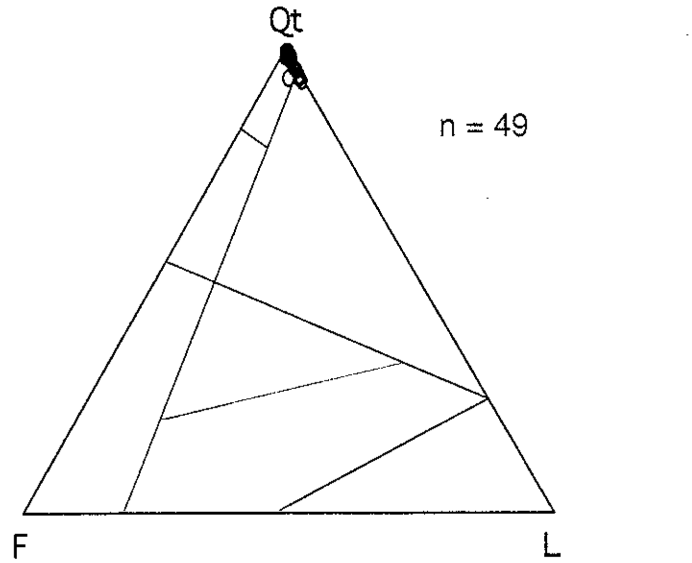


Figure 2. QFL plot representing composition of all samples frrom petrographic pt count data.

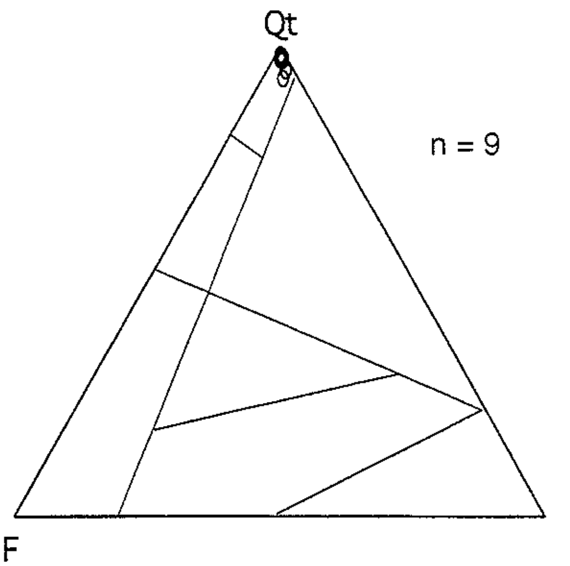


Figure 3. QFL plot representing composition of chemically analysed samples from petrographic pt count data.

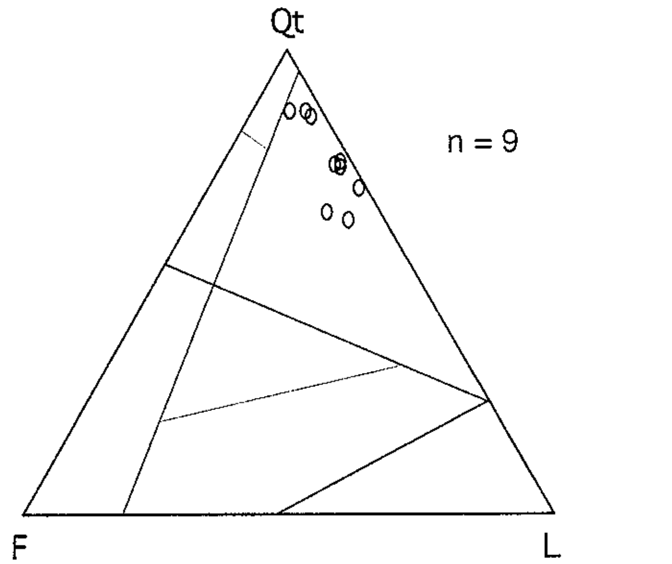
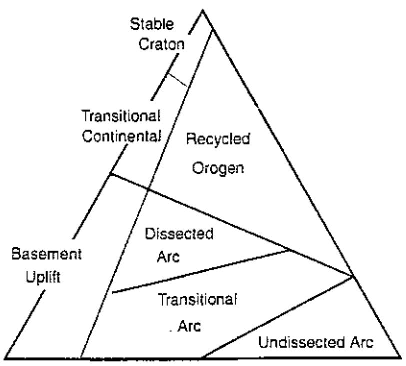


Figure 4. QFL plot representing reconstructed compositions of chemically analysed samples.



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