Petrology and stratigraphy of Upper Deadman Quartzite, Mazatzal Mountains, Central Arizona

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INTRODUCTION

The Mazatzal Group is a 1.5 km thick siliclastic succession that consists of the Deadman Quartzite, Maverick Shale, and Mazatzal Peak Quartzite (Conway and Wruke, 1986). The Deadman Quartzite lies above the Red Rock Rhyolite in the Mazatzal Mountains, and is divided into upper and lower members by a rhyolite ashflow tuff. This study focuses on the upper member of the Deadman Quartzite.

The rocks of this study are located in the Mazatzal Mountains and at Tonto Natural Bridge National Park (Fig.1). This project included the construction of four detailed stratigraphic sections and descriptions of the Upper Deadman Quartzite, combined with petrographic analyses of samples collected at each of the sites. The detrital component of the Upper Deadman Quartzite is almost entirely quartz, with minor amounts of feldspar and heavy minerals. The compositional maturity is surprising due to the extensive tectonic activity in the area at the time of deposition. The purpose of this petrographic study is to understand the sedimentary and diagenetic history of the Upper Deadman Quartzite.

METHODS

Four sites were chosen where the Upper Deadman Quartzite is well-exposed in outcrop. The upper member had been positively identified in Shake Tree Canyon (two sites) and along the North Peak Trail. At Tonto Natural Bridge, the unit studied had only been identified as quartzite in the Mazatzal Group. A layer of rhyolite at Tonto Natural Bridge may be correlative with the rhyolite layer in the Deadman Quartzite of the Mazatzal Mountains, indicating that the overlying stratigraphic unit was presumably the Upper Deadman Quartzite. Detailed stratigraphic columns ranging in thickness from 24-60 m were measured at each of the four sites (Fig.2). A suite of samples was collected at places where there were distinct changes in the character of the quartzite. Thin sections of the samples were point counted. Approximately three hundred points were done per thin section for a variety of detrital grains and diagenetic features.

FACIES DESCRIPTIONS

Facies 1 is predominantly massive, fine to very fine grained quartz arenite, with sub-rounded to rounded grains. This facies includes occasional trough cross-beds (5 to 15 cm thick) and amalgamated normally graded beds (5 to 40 cm thick). Facies 2 consists of fine to very coarse-grained quartzite with subrounded to rounded grains. It contains abundant sets of tabular and trough cross-beds, 5 to 60 cm thick. Facies 2 also includes many 10 to 50 cm thick normally graded beds. Facies 3 consists of thin pebble conglomerate layers which are 1 to 2 clasts thick. The pebbles are subrounded to angular, some are flattened, and all are composed of either quartz or rhyolite. Facies 1, 2 and 3 occur at all four study sites.

Facies 4 occurs only at the North Peak (NP) site. This facies includes 1 to 5 cm thick beds of very fine sandstone to siltstone. Many beds have rippled surfaces with features including: crest spacings 1 to 15 cm, heights from 0.5 to 4 cm, some bifurcation on symmetrical ripples, some slightly asymmetrical ripples, and some flat topped ripples. Additional structures include wrinkle structures and desiccation cracks.

Facies 5 and 6 occur only at the Tonto Natural Bridge (TNT) site. Facies 5 includes several brick-red mudstone beds 5 to 20 cm thick, with no macroscopic sedimentary structures. Facies 6 includes several meters of convolute-bedded, very fine sandstone to granular conglomerate with rounded to subrounded grains. Beds show normal grading, small-scale trough cross-bedding, and small-scale tabular cross-beds 6 to 10 cm thick. Many of the beds are broken up, and some beds are overturned.

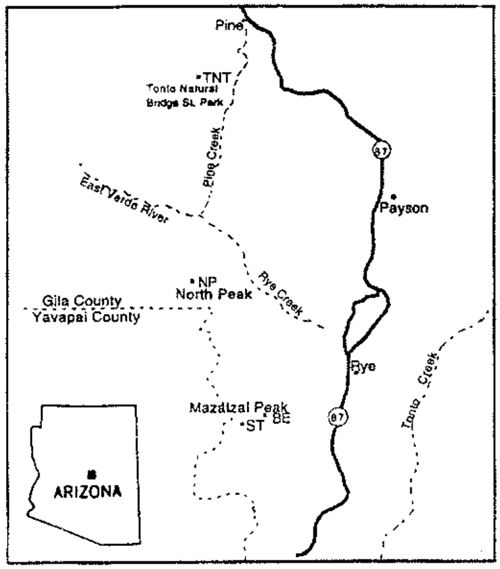

Figure 1. Map of general field area in central Arizona with field sites detailed.

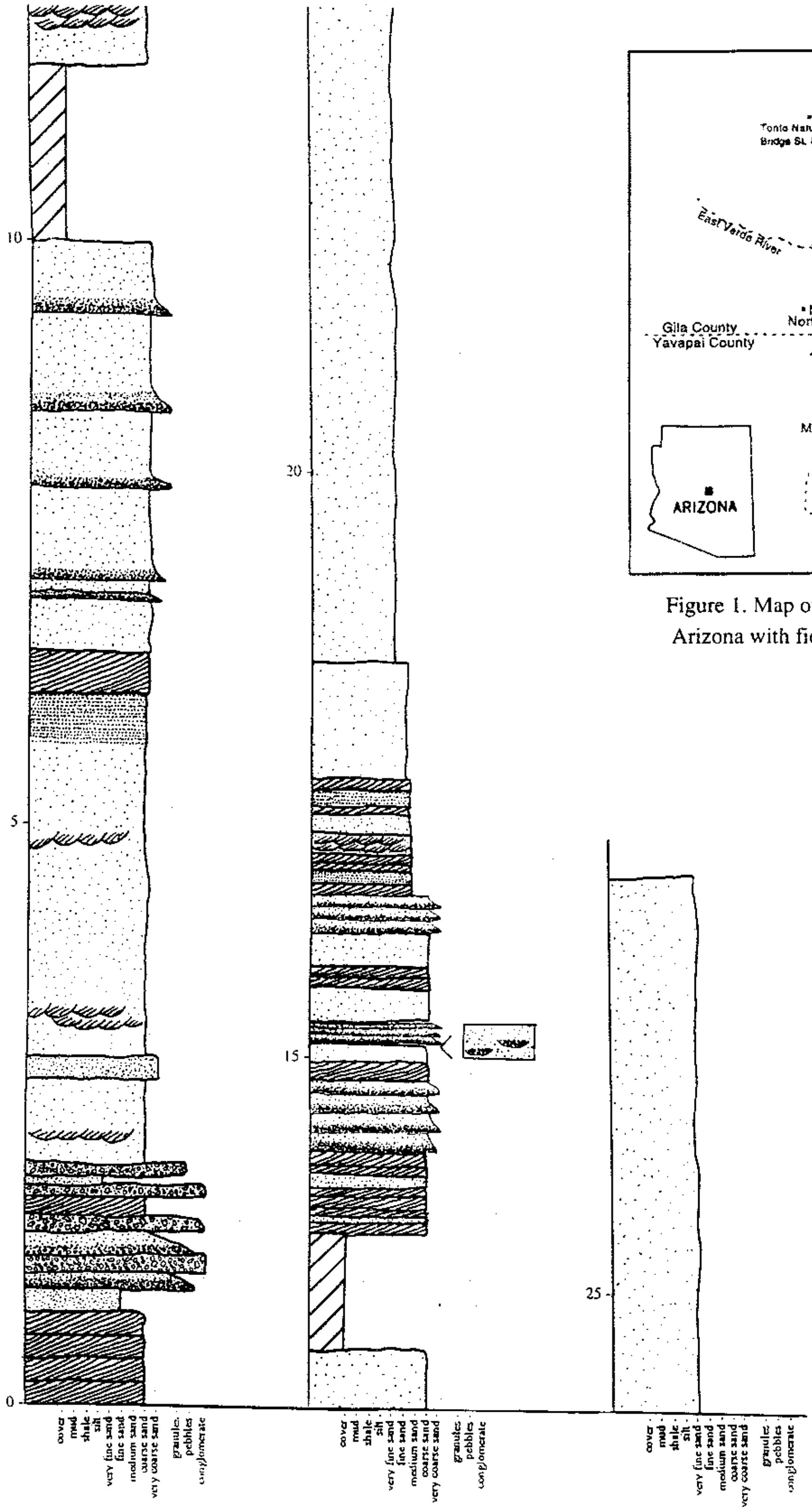

Figure 2. Stratigraphic column of Upper Deadman quartzite in Shake Tree Canyon site **ST-1**.

Table 2. Petrographic analysis of samples*

SAMPLE	mono. Qtz	poly. Qtz	qtz. Cmt	matrix	feldspar	heavy min	lithic	mica
ST-1	68.7	15.5	9.9	1.9	4.0	0.0	0.0	0.0
ST-2	72.0	15.6	9.6	1.9	0.0	1.0	0.0	0.0
ST-3	66.0	4.2	3.1	16.0	0.0	10.7	0.0	0.0
ST-4	62.2	10.0	8.1	14.4	0.0	5.3	0.0	0.0
ST-5	68.2	1.9	1.9	19.8	0.0	8.3	0.0	0.0
TNT-1	63.8	11.0	6.3	16.7	0.0	2.2	0.0	0.0
TNT-2	73.2	7.5	2.5	15.6	0.9	0.0	0.3	0.0
TNT-3	54.7	8.2	2.5	33.2	0.0	1.3	0.0	0.0
NP-1	54.5	8.7	8.0	9.6	18.6	0.6	0.0	0.0
NP-2	78.7	14.5	3.6	2.7	0.0	0.6	0.0	0.0
NP-4	46.4	2.8	0.0	50.8	0.0	0.0	0.0	0.0
BE-2	37.8	0.9	0.0	57.3	0.0	4.0	0.0	0.0
BE-3	77.4	14.7	3.4	3.1	0.0	0.0	0.3	0.9

SAMPLE **	quartz	feldspar	lithic
ST-1	95.4	4.6	0.0
ST-2	100.0	0.0	0.0
ST-3	100.0	0.0	0.0
ST-4	100.0	0.0	0.0
ST-5	100.0	0.0	0.0
TNT-1	100.0	0.0	0.0
TNT-2	98.5	1.1	0.4
TNT-3	100.0	0.0	0.0
NP-1	77.3	22.7	0.0
NP-2	100.0	0.0	0.0
NP-4	100.0	0.0	0.0
BE-2	100.0	0.0	0.0
BE-3	99.7	0.0	0.3

*Data are in volume %.
**numbers equal % normalized to 100%; non-QFL components excluded

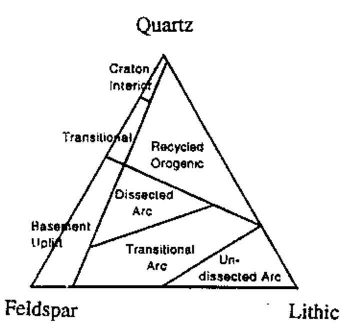

Figure 3. QFL plot of provenance fields as defined by Dickinson (1985)

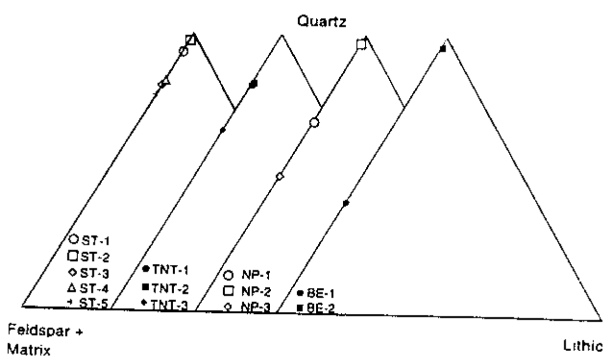

Figure 4. QFL plot representing the composition of samples using the assumption that all the matrix formed from the diagenesis of feldspar grains.

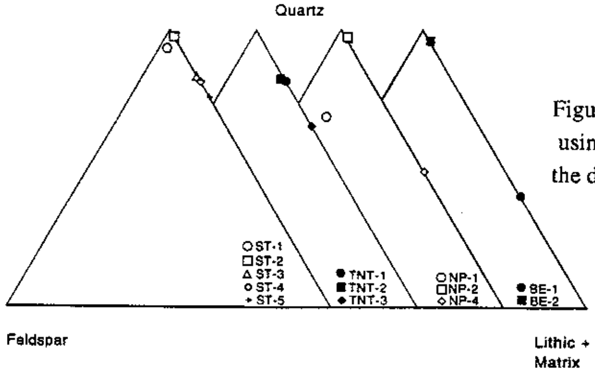

Figure 5. QFL plot representing the composition of samples using the assumption that all the matrix formed from the diagenesis of lithic fragments.

PETROGRAPHY

Detrital Framework Analysis. Point counts were performed on thin sections representing each of the four measured sections . Sections **TNT**, **NP**, and **BE** all sit on Red Rock Rhyolite, while **ST** begins at an unknown height above the base of the Upper Deadman Quartzite Unit.

Framework grains range from 77.25% - 100% quartz, 1.14 – 22.75% feldspar (found in only three samples), and very minor (less than 1%) amounts of lithic fragments (Table 2). In samples **TNT-3**, **BE-2**, **NP-1**, and **NP-4**, the edges of quartz and feldspar are highly irregular and ragged. Some samples also show matrix grains within quartz grains. These features provide convincing evidence of extensive replacement of quartz and feldspar grains by coarse sericitic matrix. Large matrix filled areas which separate clast-supported framework grains also give evidence for this diagenetic alteration. In some samples the matrix-filled areas are as large or larger than the surrounding grains, and it is likely that those areas were once filled with larger labile grains such as lithic fragments or feldspars. For example, in sample **NP-1**, diameters of clast-supported grains are 0.5 to 1.25 mm, whereas diameters of the matrix-filled areas are 0.5 to 1.5 mm. In sample **NP-4**, diameters of clast-supported grains are .05 to 0.22 mm, whereas diameters of the matrix-filled areas are 0.11 to .33 mm There are significant amounts of monocrystalline and polycrystalline grains in samples, the latter of which were likely eroded from metamorphic rocks. Several samples also have significant amounts of quartz cement, and pressure solved quartz grains are abundant in sample **ST-1**.

Cements and Matrix. Most samples contain small amounts of quartz cement, ranging from 1.85% to 9.91%. All samples contain amounts of sericite matrix ranging from 1.86% to 57.28%. The sizes of matrix crystals range in diameter from 0.005 to 0.044 mm. The matrix in sample **TNT-3** appears to have been deposited on top of quartz grains rather than in between them.

DISCUSSION

The four measured sections contain very few features that are diagnostic of the paleoenvironment for the Upper Deadman quartzite. Desiccation cracks are diagnostic features, but they are only found in a small interval of one of the four sections (**NP**). The question remains as to whether the absence of desiccation cracks in other sections is a result of the absence of mud, or the fact that the sections were not exposed. Because there are so few diagnostic features it is unclear whether the original setting for the unit was marine, non-marine, or a combination of the two. The assemblage of desiccation cracks and wave ripples found at the North Peak site suggest possible marine shoreline deposits. The massive quartzite and dune-scale cross-bedding that is found in the other sections suggest a fluvial *or* a shallow marine environment. If the setting was fluvial, however, more evidence of channeling and fining upward cycles would be expected.

The petrographic analysis of samples was also inconclusive regarding paleoenvironment. The high contents of sericitic matrix, along with the nature of the matrix, suggest it formed from the diagenesis of labile grains such as feldspars or lithic fragments. Previous work done on the Mazatzal Group quartzite has suggested that the high matrix percentages in the unit result from the diagenesis of lithic fragments. Cox and Lowe (1996) found low percentages of lithic fragments, and even lower percentages of feldspars in their samples from the Mazatzal Group quartzites. Their chemical analyses also indicated that the matrix formed primarily from lithic fragments. The data collected in this study, however, indicates that the high matrix percents may have resulted primarily from the diagenesis of feldspars. Three samples contained significant amounts of feldspar, while only two samples contained lithic fragments, each making up less that 0.5% of the sample's constituents (Table 2). QFL plots show hypothetical provenances for the samples assuming that the matrix formed from the diagenesis of feldspars (Fig. 4) and from the diagenesis of lithic fragments (Fig. 5). These plots are reconstructions of possible end-member compositions of the initially deposited sediment. The QFL plot which assumes the matrix formed from the diagenesis of feldspars (Fig. 4) is more realistic according to the data collected in this study. This means the provenance of the samples would likely be the craton interior or the transitional zone between the craton interior and basement uplift.

REFERENCES

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