AN ANOMALOUS BRECCIA IN THE MESOPROTEROZOIC (~1.1 Ga) ATAR GROUP, MAURITANIA: POTENTIAL EVIDENCE FOR AN IMPACT-GENERATED TSUNAMI. D. J. Aden[1], K. A. Milam[2], L. C. Kah[3], and G. J. Gilleaudeau[3]. [1]Department of Geological Sciences, Ohio University, Athens OH 45701, da109304@ohio.edu, [2]Department of Geological Sciences, Ohio University, Athens OH 45701, milamk@ohio.edu, [3]Department of Earth & Planetary Sciences, University of Tennessee, Knoxville TN 37996, lckah@utk.edu.

Introduction: An anomalous breccia unit exists within the Mesoproterozoic-aged Atar Group on the West African Craton (WAC). This unit is unusual because its sedimentary features record a high energy event in what was an otherwise calm marine depositional environment. In order to ascertain a depositional mechanism for this unit, breccia and megabreccia formational mechanisms and their respective morphological descriptors are being evaluated for their potential to explain initial field observations of the breccia. Preliminary observation presents the possibility that the impact of a large meteorite is capable of producing tsunamis and ejecta that may have resulted in this style of deposition.

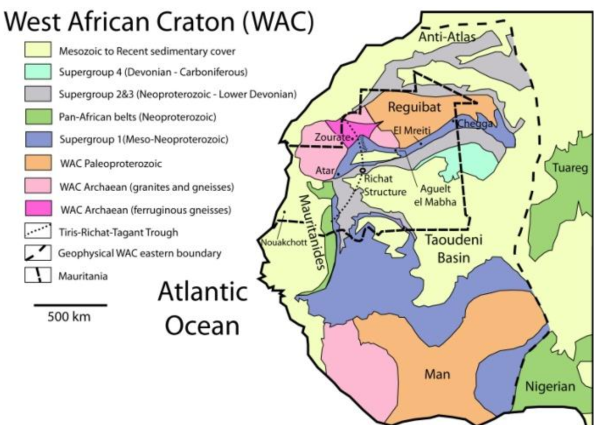

Figure 1. Geologic map of the West African Craton, modified from [1-5].

Background: The WAC is a large (~4 million km^2) portion of the African continent composed of the ancient Man and Reguibat Shields (Figure 1).WAC was assembled into its present configuration during the Eburnean orogeny at 2 Ga [1] and has since remained tectonically stable. After assembly, during the Mesoproterozoic, the extensive Taoudeni Basin formed by subsidence which, combined with eustatic sea level changes, resulted in shallow marine sedimentary deposition. Deposits in this basin are divided by discontinuities into 5 supergroups. The unit of interest lies within Supergroup 1 (1.2-1.1 Ga, up to 3500 m thick). Supergroup 1 is composed of dolomitic carbonates, shales and siltstones and is further divided into three groups (Assabet el Hassiane, Atar, and Char). The Atar Group (1.2-1.1 Ga [5]) is 550 m thick (near Atar) and is exposed across 1500 km of the WAC. The Atar Group is composed of epeiric marine shales and stromatolitic carbonates and contains the Tawaz Formation in which the breccia is located.

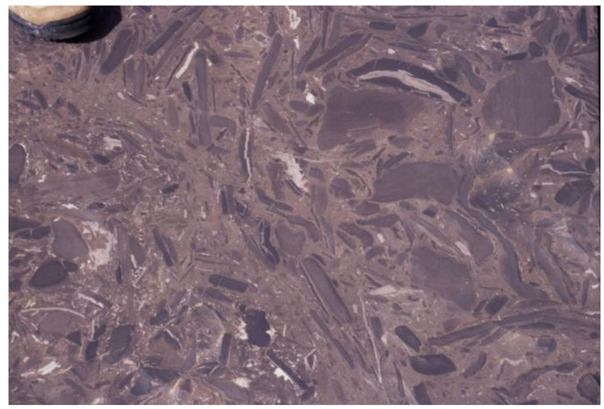

Figure 2. Plan view of the Tawaz Breccia with aligned (preserved flow) and randomly oriented clasts.

Anomalous Unit: This unit is considered anomalous because it records a extraordinarily high-energy depositional environment within an otherwise normal marine setting. A vertical transect across the breccia includes stromatolitic carbonate bioherms suggesting a relatively low energy, marine depositional environment; to microfaulted carbonates, ball and pillow structures, and fluidized beds just below the breccia. The Tawaz Breccia (Figure 2) itself is 2-6 m thick and is composed of discrete amalgamated units that contain a wide range of clasts (mm to >70 cm in diameter), and a matrix of microspar cement, indicating rapid lithification [6]). Amalgamated subunits feature erosional scour surfaces at the base, and indication of high-viscosity deposition (suspended clasts, fluid deformation features), and bidirectional clast imbrication. The breccia is also marked by considerable vertical and lateral facies variation throughout. The carbonate unit above the Tawaz Breccia represents a return to normal marine, stromatolititic deposition.

Purpose: In order to identify the geologic process responsible for deposition of the Tawaz Breccia, physical properties of this unit are being compared to breccias and megabreccias produced by other means *i.e.* tsunamis, turbidites, storms, tectonism, pyroclastic, autobrecciation, hyaloclastic, landslide/slump, collapse, glaciers, and impact. Key field observations such as clast size, clast variability, degree of sorting, rounding, type of support, and clast composition, along with morphological descriptors such as depositional environment and lateral extent, can be used to narrow the most probable formational mechanisms and perhaps distinguish between them.

Initial Eliminations: Initial field and lab observations have allowed us to exclude several breccia/megabreccia formational mechanisms. The lack of apparent igneous clasts or melt in the breccia precludes formation by volcanic deposition. Subaqueous landslides, slumps, turbidites, and sediment gravity flows are typically restricted to deeper water and steeper gradient settings than that in which the breccia was deposited (as indicated by initial studies by LCK in and around the Atar region). These mechanisms transport shallow marine sediments down slope whereas initial observations of clasts indicates potentially upslope transport of deeper marine clasts onto the platform.. Glacial mechanisms can also be excluded since there is, globally, no indication of glacial activity in the Mesoproterozoic. Tectonic breccias can be distinguished by their requisite confinement along tectonically-active margins or in close proximity to faults. The Atar Group, however, represents cratonal deposition, with no indication of active syndepositional orogenesis. Storm deposits preserve unidirectional [7] imbrication of larger clasts (unlike the Tawaz Breccias which are bidirectional to multidirectional) and rarely contain the large rip-up clasts or boulders similar to the Tawaz Breccia. Collapse breccias from dissolution of evaporite deposits or soluble carbonates are also not a likely explanation for the breccia deposit. Although evaporite basins can be laterally extensive (several hundreds of km), evaporitic breccias are commonly not basinal in extent. Although there is evidence of localized evaporates in the Atar Group [8], the timing of deposition is substantially earlier than the development of thick, basinwide evaporite deposits, which did not arise until the Neoproterozoic [9].

Remaining Ideas: One mechanism, deposition by tsunami, can result in laterally-extensive deposits in shallow marine and onshore environments. However, tsunamis typically require a high-energy triggering event such as an earthquake, landslide, or slumping event. Since the Tawaz Breccia occurs predominantly within a large stable craton, on two distinct passive margins (in present-day Mauritania and Algeria), and is far removed from active tectonic margins, it is unlikely that any of these mechanisms occurred locally, but would have likely been extrabasinal. It has also been proposed that marine impact events could provide sufficient energy for tsunamis that could deposit allochthonous material transported from the seafloor [10]. An added component to such impact-generated tsunami deposits might be clasts deposited by ballistic sedimentation. Indicators of this may be preserved as deformation of the underlying substrate. Depending on the magnitude of the triggering impact, large clasts can be ejected long distances, contributing to the number and size of clasts transported by the tsunami. The high energy character and large lateral extent of known tsunami deposits are similar to initial observations of the breccia, and therefore the endogenic or exogenic nature of the tsunami generating mechanism will be specifically evaluated. Future work will involve geochemical analysis (by inductively coupled plasma mass spectrometry: ICP-MS) of samples collected from the anomalous unit to detect platinum group element (PGE) and siderophile element (SE) abundances and interelement ratios that are indicative of a meteoritic or exogenic component.

Conclusion: A high energy anomalous breccia exists within an otherwise calm Mesoproterozoic depositional environment of the Taoudeni Basin in present-day Mauritania. Evaluation of possible depositional mechanisms initially suggests deposition by tsunami. If the Tawaz Breccia did result from a tsunami, this study could provide a better understanding of tsunami deposits in the geologic record and may potentially identify a large impacts that has previously been undetected in the Earth's geologic record.

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