EXPLORING THE IMPACT OF GEOLOGICAL AND GEOMORPHOLOGICAL PROCESSES IN SEDIMENTARY DEPOSITS IN ABU DHABI: A POTENTIAL MARS ANALOGUE

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Introduction: Abu Dhabi (UAE) is of great interest to researchers for analogue studies of both paleo and recent environments on Mars. The Martian surface appears to have a wide range of paleo fluvial systems which led to the formation of a variety of minerals which we see today [1]. The sedimentary deposits of our study area (Abu Dhabi) show signs of various processes which are directly related and are relevant to Mars's fluvial history. Our study area is located in the Abu Al Abyad Area (24°03'31.5"N 54°01'49.3"E), Abu Dhabi, United Arab Emirates (Figure1a). The Stratigraphy of this area appears to be associated with Baynunah Formation [2]. Our aim is to study the impact of geomorphological processes on Earth and investigate the possibility of similar processes on Mars. Mineralogical correlative studies can help us explore the fluvial history of Mars and assist in interpretation of data from Mars rovers and plan future exploration on the planet.

Fieldwork & Methods: Fieldwork was carried out at an area where deltaic deposits and recent alluvial fan deposits were found near the Abu Al Abyad, Abu Dhabi. In the field, we megascopically collected and identified samples, and studied the geomorphic features to understand the fluvial history of the area. The samples were analysed on Powder X-ray Diffraction (PXRD) at Core Lab, New York University Abu Dhabi (UAE) to study the samples in greater detail.

Geology of the analogue site: On Mars, the dichotomy region is anticipated to have witnessed both fluvial and **possible marine** sediments. Our analogue site is geologically referred to as a Quaternary transitional delta deposit. Later, it was episodically altered by the prevailing fluvial, marine, and wind activity. We observed the layer strata that exhibit the episodic events of fluvial activity in the past, but at present it appears to be dried Sabakha [2][5]. The large flat mount had recent fluvial erosion to form the small alluvial on the North side, which had recently altered sediments (Figure1a). The fluvial and aeolian erosional activity on the earlier deposit formed these butte landform features (Figure1a&1b). Butte-like exposures, a cap-rock made of sandstone and carbonate with displacive gypsum-anhydrite and chert veins, generally form a resistant tabular top (Figure 1b) [3][4]. Cross-stratified conglomerates are the base strata of the Baynunah Formation [2] and Abu Al Abyad (Figure 2a). It exposes the deltaic depositional characteristics. Clay minerals combined with carbonate sediments in the middle part of the butte (Figure 2b) [2] [5], which was formed by the fluvial marine deposits. Neogene sedimentary deposits like marls, sandstone, limestone, and evaporites like [6] salts are orderly overlain by the conglomerates. Miliolite (aeolinite) is formed by aeolian activity [7] [4]. As Mg carbonate (Magnesium Carbonate) occurs with Gypsum in this Abu Dhabi region, it is an early diagenetic mineral, as it has been previously interpreted [8] [9]. High Mg carbonate as Aragonite was present only in the brown sediment [9]. Mg Ca carbonate (dolomite) was formed as a recent marine deposit(Figure 2c). Gypsum was the most abundant mineral that occurs as a crystal and mush when mixed with sand grains, as shown in Figure 2d [3]. Fossils and organic matter like algae are also reported in this region [5][8]. These mineralogical aspects are similarly deposited like those on Mars, which helps to understand the Martian depositional characteristics

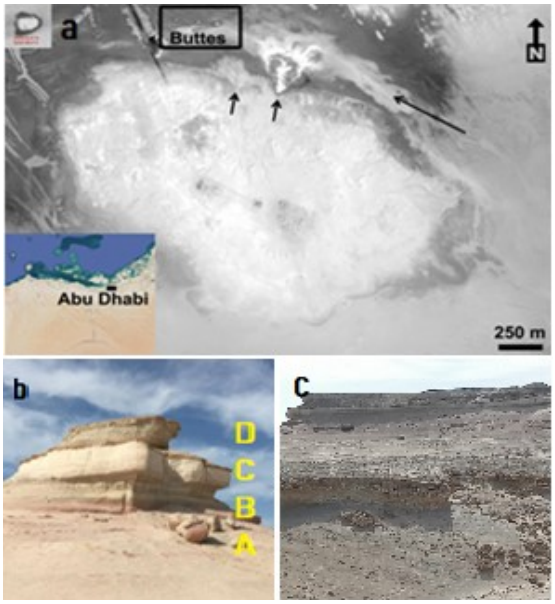

Figure 1 a) Geomorphic features are referred in this Satellite map of Al Abu Abyad, Abu Dhabi, UAE.(Arrow refer the water flow direction). b) Butte landform. A, B, C, D refers the strata of butte. c) Butte feature surrounded by transitional deposit

Butte strata:

Figure 2.a) Conglomerate pebbles [A] b) Clay with Dolomite[B] c) Dolomite [C] d) Gypsum [D].

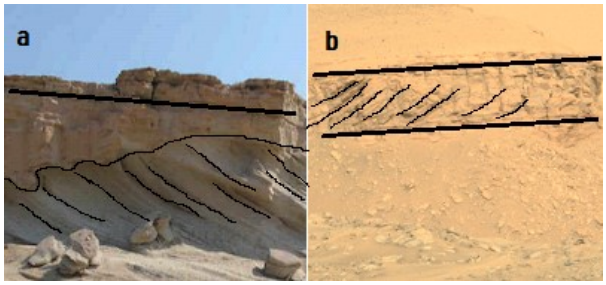

Figure3. Cross stratification at analogue site and Jezero crater mars. a) Baynunah formations cross stratification [2]. b) Mars cross stratification at Jezero crater [14].

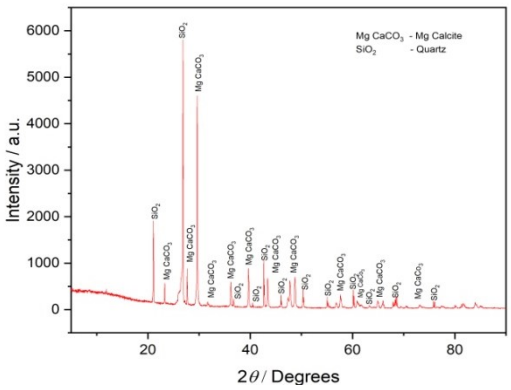

Figure4. PXRD data of sample 3. The sample expresses the dolomite and silica peak.

Mineralogical analysis: PXRD analysis shows that samples are rich in carbonates. A Sample from the B layer contained 65 % Mg $CaCO_3$ and 35 % SiO_2 minor traces of other elements might be present but were not identified in Figure 4. The sample of the C layer had 83% Mg $Ca(CO_3)_2$ and 17% SiO_2 .Dolomite is the major mineral in this strata, also mixed with sediments like quartz. Megascopically, we can identify the gypsum crystals in the D layer. These high amounts of carbonate express the recent marine chemical alteration of older sediments. The quartz grains resisted that alteration.

Results: The cross stratification of fluvial deposits compared with the Jezero crater delta system is shown in Figures 3a&3b [11]. From the analysis of its paleo-morphology, we interpret the Abu Dhabi sediment deposit system as an ancient delta deposit that formed at the margin of a standing body of water in the late Quaternary. Conglomerate pebbles are transported by fluvial and tidal activity [2]. The carbonates of Ca, Fe, Mg [Dolomite, Calcite, Siderite, Magnesite, Aragonite] were formed by the fluvio-lacustrine deposits [12]. Clay (Mg) was formed by the fluvial deposit associated with carbonates [1]. Sulfate [ca] [Gypsum-Anhydrite] is formed by the evaporites on the surface [13] [14] and expresses as a dried lake, or Shabkha. This suggests that the sedimentary depositional environment has been episodically altered by various processes which correlate to Martin depositional characteristics. These mineralogical assemblages are counterparts of the wide mineralogical assemblages on the dichotomy of Mars. Our analogue site has frequent erosion, transportation, and deposition by various geomorphic agents. Buttes contain sedimentary rocks, which is a key feature for exploring Martian paleoenvironments. The presence of calcium carbonate in the soil has implications for our understanding of Mars. Calcium carbonate buffers an alkaline pH, which is similar to that of many habitable environments, notably terrestrial sea water [15]. This study could be one way to understand Mars's fluvial history and help with the exploration of Mars in the future.

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