MARS ANALOG SIGNIFICANCE OF CONCRETIONS IN EXHUMED AND INVERTED CHANNELS NEAR HANKSVILLE, UTAH.

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Introduction: The landscape of the Mars Desert Research Station near Hanksville, Utah, contains a diversity of Mars analog features [1]. These include segmented and inverted anastomosing (occasionally meandering) paleochannels exhumed from the Late Jurassic Brushy Basin Member of the Morrison Formation. The channels host abundant small carbonate concretions.

The exhumed and inverted channels closely resemble many seen on the surface of Mars in satellite imagery [2], [3] and which may be visited by surface missions in the near future [4], [5]. The channels contain a wealth of paleoenvironmental information pertaining to depositional and diagenetic environments. They are distinct from the slightly younger inverted channels described from near Green River Utah [6].

The concretions, both morphologically and in surface expression, resemble the hematite "blue berries" strewn across the surface of Meridiani Planum [7], [8]. They are best developed in poorly cemented medium to coarse channel sandstones and appear to have formed during burial.

Facies: Facies in the Brushy Basin Member (BBM) have been extensively described in the literature, e.g. [9], [10]. The BBM was deposited in a foreland basin setting draining highlands to the west and a marginal to enclosed evaporitic basin to the east. The paleoclimate was an arid to semi-arid environment. We have observed two major facies, channels and floodplains.

Channels. These facies are composed of more permeable sediments such as sands and gravels than their floodplains or valley sides which are more likely composed of silts and clays. Their greater permeability results in high rates of fluid flow and greater likelihood of cementation compared to their flanking materials. In the study area, paleocurrents indicate flows in a generally north-easterly direction.

Floodplains. The floodplains consist of smectite-rich (montmorillonite and nontronite), red brown and occasionally green shales. Iron and silica-cemented paleosols are common. Interbedded with the shales are thin crevasse splay sandstones.

Geomorphology: Lowering of the landscape through denudation processes such as mass wasting, fluvial dissection, or aeolian deflation will exhume the channels, leaving the more indurated examples as ridges in the landscape, inverting the former topography [2], [6]. In the study area the paleochannels are now commonly expressed as numerous segmented sinuous ridges. The resistant sandstones and conglomerates of the channels form cap rocks that protect the underlying floodplain clays from erosion. Eventually the cap rocks are removed by scarp retreat, leaving isolated boulders, the clay ridge then being vulnerable to erosion.

Concretions: The concretions are 3-10 mm in diameter, most commonly 5 mm. They are spherical to sub-angular, most commonly sub-rounded. Occasional irregular concretions are present. Occasional doublets formed when two grew close enough to merge, rarely concretions can amalgamate to form multi-nucleate masses. When exposed on a freshly broken surface the concretions are white in color. They weather purplish or brown. XRD and SWIR spectroscopy analysis shows the presence of calcite, staining indicates some calcite is slightly ferroan in composition.

Concretions distribution is controlled by depositional setting, they are most common in medium-grained channel sandstones, less common in fine-grained or pebbly channel sandstones. Degree and nature of cementation also appears a factor, concretions occur mostly in moderately indurated sandstones cemented by calcite, they are absent from poorly cemented sandstones and those that have been well cemented by silica.

Because they are more indurated than the surrounding sandstones, the concretions tend to weather out of the rock. In the process the surface of the concretions acquires a purplish or brownish color, suggesting traces of manganese and iron in the carbonate. The liberated concretions are reworked by slope processes to form deposits mantling slopes and as lags within rills and gullies.

Mars analog significance: Both the channels and the concretions are valuable Mars analogues.

Channels. Satellite images of Mars have revealed that numerous inverted and exhumed fluvial channels are present on the Martian surface [2], [3], [11]. These include single and anastomosing streams, fans and deltas, and fixed and migrating high sinuosity channels. As anastomosing fixed channels, the MDRS examples, although segmented, are among the best terrestrial analogs yet identified for those of the Aeolis region on Mars [3]. The complex terrain and segmentation of the exhumed and inverted channels at the MDRS site also provide superb exposure and access to study the detailed fluvial architecture.

The exhumed terrestrial paleochannels are prime locations for the preservation of microfossils and, when inverted and exhumed, provide excellent sampling sites [12]. Exhumed and inverted channels on Mars can also be expected to host such remains, if they exist. Terrestrial paleochannels have also provided refugia for organisms as climates shift from equitable to more arid over timescales of tens of millions of years and formerly surface organisms adapt to habitats in the sedimentary pores [13].

Concretions A number of terrestrial concretions have been proposed as analogs of the Meridiani "blueberries" [14], [15]. Which of these are the best analogs depends on the feature under investigated. Those of the Brushy Basin Member are the best analogs in terms of their size, extent, sphericity, and surface expression.

Only hematite concretions have been found on Mars to date. But the detection of diagenetic carbonate in sediments inside Jerezo Crater [16] hints at carbonate-overprinted sediments on the planet, at least locally.

Conclusions: The inverted and exhumed channels and their associated concretions at MDRS are useful Mars analogs that assist in understanding sedimentary, diagenetic and geomorphic processes and history, may predict the details that will be encountered when such features are explored at ground level by future Mars missions, and provide testing grounds for the technology and instrumentation required for their study. They add considerably to the already extensive Mars analog value of the MDRS facility and its environs.

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Fig. 1. Thirty m high inverted paleochannel, MDRS.

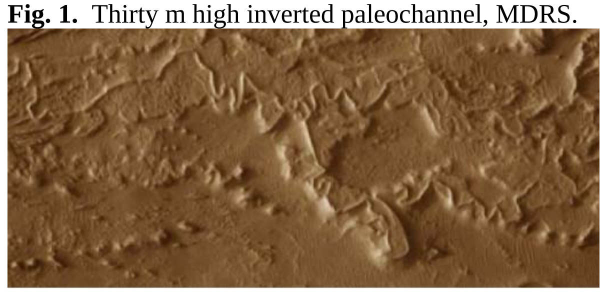

Fig 2. Inverted paleochannels, Aeolis, Mars, from [3].

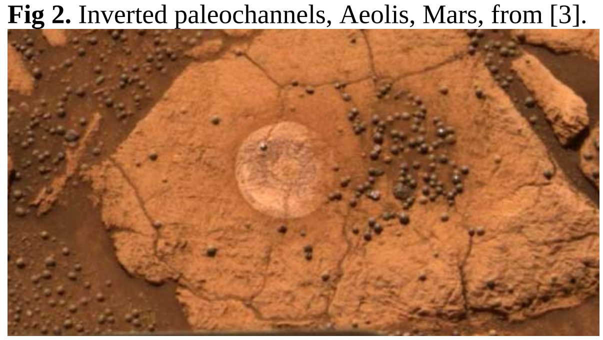

Fig. 3. 3-5 mm hematite concretions, Meridiani

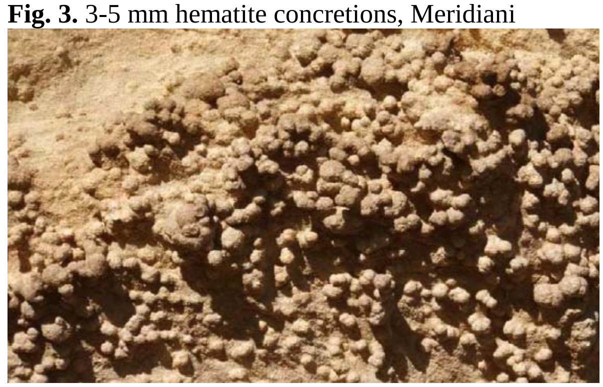

Fig. 4 3-5 mm $CaCO_3$ concretions in sandstone, MDRS.