DIVERSITY AND DOWNSLOPE TRANSITIONS OF EXHUMED FLUVIAL SYSTEMS IN ARABIA TERRA, MARS.

J. M. Davis[1], M. Balme[2], S. Gupta[3], P. M. Grindrod[1], P. Fawdon[2], and R.M.E. Williams[4]. [1]Dept. of Earth Sciences, Natural History Museum, London, UK, joel.davis@nhm.ac.uk, [2]Dept. of Physical Sciences, Open University, Milton Keynes, UK, [3]Dept. of Earth Science and Engineering, Imperial College, London, UK, [4]Planetary Science Institute, Tucson, AZ, USA.

Introduction: Numerous depositional channel systems are present in Arabia Terra, the most northern part of Mars' Noachian, > 3.7 Ga, southern highlands, preserved in inverted relief as inverted channels [1, 2]. The fluvial systems are strong evidence that channel and non-confined overbank deposits developed in a depositional environment in parts of Arabia Terra, almost certainly during the Noachian. These exhumed channel systems occur in association with erosional valley networks [3], paleolake basins [4], and with no clearly preserved catchment region.

We used CTX and HiRISE data to investigate the morphology of inverted channels and show key examples of their relationships to associated fluvial landforms throughout Arabia Terra. We produced CTX and HiRISE digital elevation models (DEMs) to make topographic measurements and examined the relationship of our database of inverted channel bodies to previously published datasets of valley networks and paleolake basins [3, 4]. Finally, using these combined data, we examined the planview morphology, stratigraphy, and transitional relationships of the fluvial systems, to assess their formation environment.

Observations:

Morphology of Inverted Channel Bodies. Segments of exhumed depositional channel systems are present throughout much of Arabia Terra. These have branching, anabranching and sinuous planforms, although highly sinuous examples are not observed (Figure 1, 2). Internally, individual ridges comprise numerous sub-horizontal layers, with differing levels of resistance to erosion (Figure 1a), and ridge segments are also vertically stacked. The material adjacent to the inverted channel bodies is also layered and occurs vertically between ridge segments. We also note that some ridges appear to be the amalgamation of multiple channel bodies. (Figure 2b). Inverted channel bodies also breach local topographic depressions and are laterally contiguous with indurated sedimentary mounds (forming both open and closed systems; Figures 1b, 2a), that we interpret as the sites of possible paleolake basins and deposits.

Relationship to Erosional Valley Networks. Examples of inverted channel bodies are found that are (1) bound by erosional valley networks and (2) transition downslope from valley-bound inverted or negative relief channel systems into

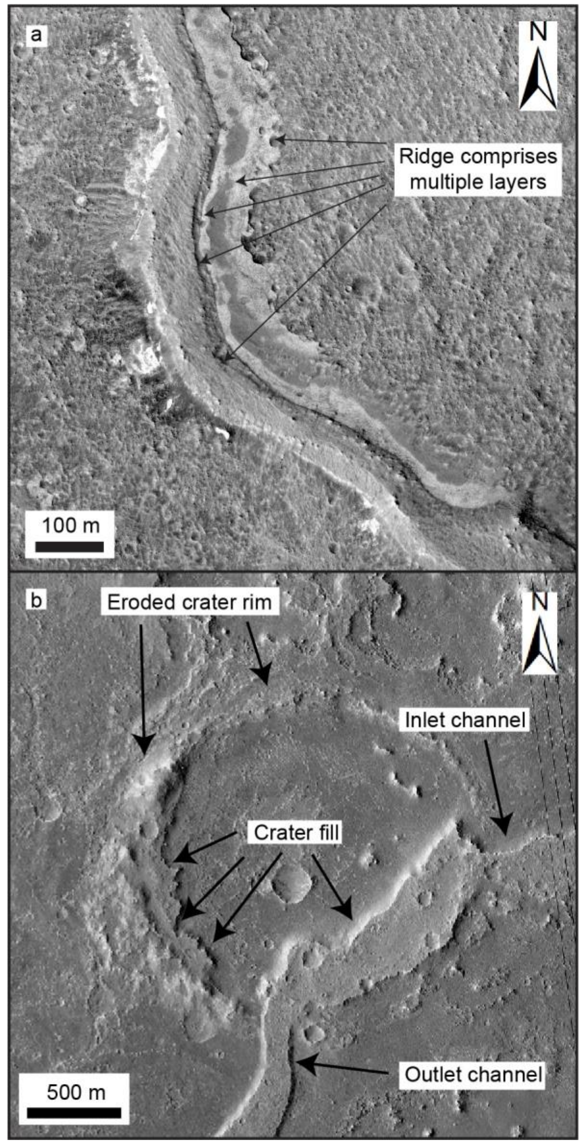

Figure 1: (a) HiRISE image of inverted channel segment comprising multiple layers with differing erosion resistance. (b) HiRISE image of infilled crater with both an inlet and outlet inverted channel, forming an open-basin paleolake. The rim has been extensively modified and possible lacustrine deposits are found on the interior of the crater rim.

non-valley bound inverted channel systems. These types of inverted channel systems are found in the downslope sections of valley networks (e.g., Naktong and Scamander Vallis) and where a valley network approaches and enters a basin (e.g., at the distal ends of

Locras and Cusus Valles). Inverted channel bodies typically increase in width as they pass into the basin. Valley-channel transitions also occur along the walls of crater basins (Figure 2a). We found one example of a 100 m high sinuous ridge cross-cut by a ~ 600 m deep erosional valley (Auqakah Vallis; Figure 2b).

Discussion:

Development of Channel Body Deposits. The characteristics of the inverted channel bodies are best explained if they represent the exhumed remains of channel-belt and floodplain deposits which aggraded vertically [6]. We suggest that the sinuous ridges comprise a stacked set of ribbon-form sandstone channel bodies and overbank (mud-rich) deposits and that the material marginal to the inverted channels represents mainly overbank deposits. This interpretation is supported by the planview morphology of the sinuous ridges, their "cliff and bench" erosional profile, the stacking of multiple channel bodies, the possible horizontal amalgamation of multiple channel bodies, and the characteristics of the adjacent marginal material. The indurated sedimentary mounds contiguous with inverted channels may represent paleolake deposits that aggraded in impact craters, the rims of which were later eroded away to leave exhumed sediment bodies.

Filling and Incision of Erosional Valleys and Basins. Erosional valley networks have been partially infilled by fluvial deposits, indicating a history of both erosion and deposition. Initial downcutting must have occurred to form ~ 100-250 m deep valleys, followed by their filling with aggrading channel-belt deposits. These processes could be caused by changes in water or sediment supply, or by a rise in base level. Downslope transitions to inverted channels also occur where valley networks approach basins: this could be driven by a reduction in slope and flow expansion. These inverted channel systems (e.g., Locras and Cusus Valles) remain confined as they enter the basin and infill local accommodation space (e.g., craters), leaving inverted paleolake deposits. The incision of an inverted channel by Auquakah Vallis, suggests that the channel was exhumed, prior to its later incision, indicating a possible pause and later resumption of fluvial activity, as well as a change in style from deposition to erosion.

Sediment Sources, Pathways, and Sinks. Many of the inverted channel systems associated with erosional valley networks are part of, or are indirectly connected to, the Naktong-Scamander-Mamers valley-basin system which traverses central Arabia Terra [5]. These systems have large, regional catchments, some of which may originate outside Arabia Terra, whereas others have a local catchment, which originates within Arabia Terra. Those fluvial systems in the central and eastern parts of Arabia Terra may have transported sediment towards the planetary dichotomy and northern lowlands. However, this is not the case elsewhere, where much of the sediment appears to have been stored in local paleolakes and regional-scale basins. Inverted channel systems are also found as isolated ridge systems without a clearly preserved catchment, in low-lying plains, such as those in SW Arabia Terra, which may have formed a large regional basin.

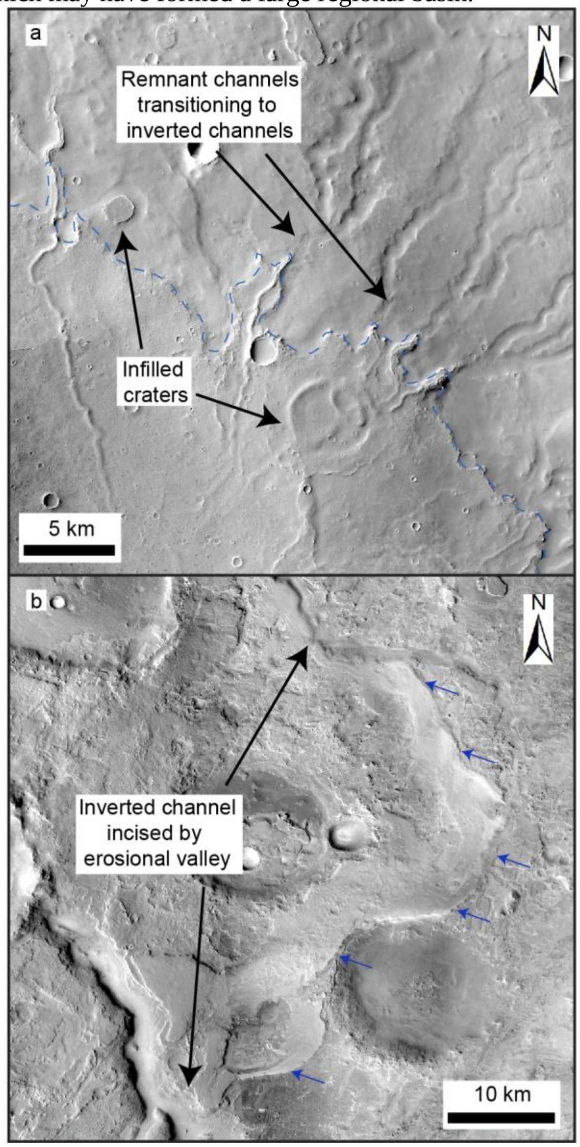

Figure 2: (a) CTX mosaic of erosional valleys on the wall of a crater basin that transition downslope into non-valley bound inverted channels. (b) CTX mosaic of inverted channel incised by an erosional valley, Aquakah Vallis.

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