FORMATION OF A TERRACED FAN DEPOSIT IN COPRATES CATENA, MARS. C. M. Weitz1, R. P. Irwin III2, F. C. Chuang1, M. C. Bourke1, and D. A. Crown1, 1Planetary Science Institute, 1700 E. Fort Lowell Road, Suite 106, Tucson, AZ 85719, weitz@psi.edu; 2Center for Earth and Planetary Studies, National Air and Space Museum, Smithsonian Institution, Independence Ave at 6th St SW, Washington, DC 20013.

Introduction: We have studied a terraced fan deposit centered at 15.0° S, 299.7° E within one of the troughs of Coprates Catena in order to investigate the role that water may have played in its formation. Only a handful of these unique terraced fan deposits have been identified on Mars [1-4], although their small sizes make them difficult to identify with the current data sets. The few fan deposits that do not have terraces and are not classified as alluvial fans in highland craters (e.g., Eberswalde crater, Nili Fossae) have been interpreted as deltas in standing bodies of water [3-7]. The terraced fan in Coprates Catena is unique among the currently known terraced fans because a contributing channel can be seen at the head of the valley that is the apparent source of sediment forming the fan deposit, and a smaller channel and associated valley incise the surface of the terraced fan deposit.

Terraced Fan Deposit: The fan deposit (Figure 1) has a maximum width of 7.9 km and length of 8.6 km, and it emanates from a 35 km long sinuous valley that cuts through the plains before terminating in the trough (Figure 2). The fan radius varies from 5.1 km at the eastern edge to 8.6 km at the northern tip. We estimate the area of the deposit to be ~40 km² and the volume to be ~17 km³. Although the fan surface is irregular and contains many scarps, slopes average ~8° along its upper surface, compared to 29° for wallrock slopes.

There are concentric scarps across the surface of the deposit, producing a terraced morphology. Using high resolution MOC images R0300723 and M0400649 that cover the eastern side of the fan deposit, we count at least 25 prominent scarps on the deposit surface, although there appear to be additional thinner and less prominent scarps as well. The narrow-angle MOC public request image S0601699 that covers the western portion of the fan reveals finer-scale light-toned layering along the fan’s edge in one particular area.

Valleys and Channels: A broad valley approximately 35 km long increases in width and depth downstream, and terminates where it enters the trough, coincident with the fan head (Figure 2). At the intersection with the trough, the contributing valley has a maximum width of 4.7 km and depth of 1.2 km. There are no tributaries associated with this valley. It is one of several valleys that we have identified in the area that trend northeast, roughly perpendicular to the NW-SE trough system of Coprates Catena.

Figure 1. Mosaic of MOC and THEMIS visible images of the fan deposit. Arrow indicates smaller valley and channel that incise the fan deposit.

Figure 2. THEMIS daytime IR mosaic with geologic features of interest.
The valley increases noticeably in depth 12.8 km before it intersects the trough, and there is a corresponding change in slope from nearly horizontal to 4°. This increase in depth and slope corresponds to where the valley transitions from a flat-floor to a V-shape at a rounded knickpoint (Figure 2). The rounded knickpoint suggests a change in lithology between the shallower southern valley floor and the deeper northern floor, with a more resistant material overlying a less resistant material. THEMIS and MOC images confirm that there are recognizable, presumably more resistant layers seen along the upper wallrock of the valley that can be traced to the same height where the knickpoint is located stratigraphically in the valley floor. The approximate volume of the valley downstream of the knickpoint is 12 km³, which is consistent with erosion and removal of this downstream portion of the valley to account for most of the material that comprises the fan deposit.

A smaller channel enters into the contributing valley to the south, but is not visible within the valley. The channel maintains a constant width of 760 m for 14 km length before broadening into a flat-floored valley. The channel has no obvious source to the south visible in the MOC or THEMIS images.

A much smaller and sinuous channel is incised along a V-shaped valley in the uppermost eastern portion of the fan deposit (Figure 1). Both the fan head valley and the channel within it are oriented along the same northeast trend as the larger contributing valley flowing into the trough. The valley is 0.3 km wide and 3.2 km long.

A light-toned layered deposit (LTLD) to the east of the fan deposit along the floor of the trough (Figure 2) may represent a water-lain deposit, perhaps an evaporitic unit formed when water from the valley partially filled the trough.

**Discussion:** We have investigated several potential origins for the formation of the terraced fan deposit including alluvial fan, volcanic flow, delta deposit, and mass wasting deposit. We favor a deltaic origin for the fan deposit, with the terraces representing erosion and re-distribution of material during each drop in lake level.

Initially, volcanic heating associated with graben formation and eruption of lavas along the plains to the south could have melted ice near the surface. The water released from this melting pooled to form the channel and valley by downcutting into the plains, with flow towards the north. Upon intersection with the trough, water incised the wallrock at this steep intersection and also began to fill the floor of the trough. As the resistant upper layers visible in the valley began to erode and the knickpoint migrated upstream, less resistant material was exposed, which could have been more easily eroded and transported downstream to be deposited as part of the fan.

As sediment and water discharge waned, the site of deposition retreated headward. Post-modification of the delta by a receding lake level could explain both the fan-shape and the terraces. If the fan deposit was emplaced subaqueously and the amount of water in the trough diminished as water flowing through the valley decreased with time, then the lake level would lower. With each drop in lake level, the fan surface at the same height of the current lake level would experience erosion and re-distribution of material at this height by wave and current movements in the water, thus producing the terraces and rounded shape of the fan.

When the discharge declined from the contributing valley, there was no longer any deposition on the fan. Instead, the final remnants of water flow incised the fan head to produce the valley and channel on the fan surface to the east. As the water on the floor of the trough sublimed or evaporated away, the light-toned layered deposits formed along the floor where pools of water collected and concentrated minerals.

The paucity of terraced fans could be attributed to the constraints required to form them, such as a nearby volcanic source and ice deposits, a steep drop from the plains into a trough or crater, and collapse/removal of upstream material due to erosion from the water movement. Unless all these conditions are met, the terraced fan deposits will not form. The lack of channels and apparent knickpoints associated with the other terraced fan deposits on Mars suggests that they probably did not form by the same scenario we have described for the Coprates Catena fan deposit. Instead, each terraced fan deposit may have slightly varying conditions during its emplacement, though each appears to result in a similar overall morphology.

**References:**