**Table 1**

Fig. 3 pedestal crater measurements. Crater depths and pedestal thicknesses are estimated from shadow measurements.

| Panel (Fig. 2) | Crater diameter (m) | Crater depth (m) | d/D | Max. pedestal extent (m) | Pedestal thickness (m) | P/C ratio[a] | Pedestal circularity[b] | $V_{pedestal}/V_{cavity}$ |
|---|---|---|---|---|---|---|---|---|
| A | 29.5 | 4.6 | 0.15 | 43.0 | 1.1 | 2.92 | 1.45 | 4.4 |
| B | 8.1 | 1.6 | 0.19 | 9.9 | 1.1 | 2.44 | 1.37 | 7.5 |
| C | 28.1 | 3.6 | 0.13 | 42.2 | 2.0 | 3.00 | 1.43 | 7.5 |
| D | 20.2 | 3.6 | 0.18 | 22.5 | 1.5 | 2.23 | 1.36 | 4.1 |
| E | 10.3 | 1.9 | 0.18 | 10.3 | 1.3 | 2.00 | 1.24 | 4.2 |
| F | 8.5 | 1.6 | 0.19 | 11.6 | 1.0 | 2.73 | 1.26 | 6.3 |
| G | 12.9 | 1.8 | 0.14 | 12.5 | 1.3 | 1.94 | 1.19 | 4.5 |
| H | 10.8 | 2.5 | 0.24 | 10.5 | 1.1 | 1.94 | 1.20 | 3.2 |
| I | 13.7 | 1.8 | 0.13 | 18.6 | 1.2 | 2.72 | 1.19 | 11.4 |
| J | 7.9 | 1.9 | 0.24 | 12.7 | 0.8 | 3.22 | 1.60 | 7.7 |

[a] The pedestal to crater radius ratio, P/C ratio = (farthest extent of pedestal) / (crater radius).

[b] Pedestal circularity = (pedestal perimeter) / $[4\pi(\text{pedestal area})]^{1/2}$.

the rim crest (Table 1). Shadow measurements were used to estimate crater depths and pedestal thicknesses (Table 1). Given a pedestal thickness of one to several meters, the crater depths (1.6–4.6 m) suggest that these craters have excavated through the pedestal substrate and into the underlying material. Depth-to-diameter ratios (Table 1) are consistent with the typical value of ~0.20 for simple craters on Mars (Garvin et al., 2003; Strom et al., 1992). Pedestal to crater radius (P/C) ratios (Table 1) are comparable to reported mean values for mid-latitude km-scale pedestal craters: ~3.3 for the northern mid-latitudes and ~2.5 for the southern mid-latitudes (Kadish et al., 2009). Values for pedestal circularity (Table 1) exceed the mean value of 1.10 reported by Kadish et al. (2009), but are less than the mean pedestal circularity of 1.64 observed in the Medusae Fossae Formation (Kadish et al., 2009). Pedestal volume to crater volume estimates (Table 1) were calculated by assuming homogenous thicknesses for the pedestals and parabolic shapes for the craters. These estimates indicate that as expected pedestal volumes substantially exceed crater volumes (Table 1).

The pedestals range from symmetric about the crater (e.g., Fig. 3A) to more asymmetric (e.g., Fig. 3E), but the morphology of the pedestal margins does not suggest strong control by a prevailing wind regime (Fig. 3). Pedestal boundary scarps are commonly sharp and well defined (Fig. 3A, C, D, G), to locally more rounded (Fig. 3B, E). Pedestal surfaces appear smooth (e.g., Fig. 3F, G) or modestly stippled (e.g., Fig. 3A, C). Fig. 3B, C, and D contain small craters or pits on the pedestals, which may suggest that these impacts were clusters (Ivanov et al., 2008). Elevated rim crests are common (e.g., Fig. 3A, C, D, H). Crater interiors appear partially filled (Fig. 3). For example, the three largest examples (Fig. 3A, C, and D) contain materials with a dune or pit-like texture, while the pedestal crater in Fig. 3I contains texturally smooth material.

### 2.2. Chronological constraints

The regional terrain underlying the pedestal craters is comprised of Amazonian lava flows emerging from the Arsia Mons region (Scott and Carr, 1978) of the Tharsis rise (Fig. 1). Locally, the pedestal craters sit on top of the northern flank of an ejecta deposit of a young 5.3 km-diameter crater (Fig. 2). Using the CraterTools extension for ArcGIS (Kneissl et al., 2011) we counted impact craters superposed on the ejecta deposit using sub-meter resolution HiRISE data (McEwen et al., 2007). A 100-m grid was implemented using Hawth's tools (Beyer, 2004) to facilitate systematic crater counting. The crater count methodology has been criticized based on interpretations that secondary craters, which result from the fallback of primary crater ejecta, are overwhelming at small sizes (McEwen et al., 2005). However, the crater counting system employs all scattered craters, including secondary craters, and recent tests have supported the system (Hartmann, 2005; Hartmann et al., 2010). Direct observations of the impact rate (Daubar et al., 2010; Malin et al., 2006) are also consistent with predictions from the isochrons (Hartmann, 2007; Kreslavsky, 2007).

On the basis of our count data, the crater size-frequency distribution observed on this deposit (Fig. 4A) suggests a best-fit age of ~12.5 Ma calculated using craters with diameters larger than 8 m. An apparent deficit of craters less than approximately 10 m in diameter occurs compared to the isochrons of Hartmann (2005). This may be attributable in part to the difficulty identifying small impact craters in relatively rough and pitted regions of the deposit. In addition small craters could also have been removed or filled by the emplacement and removal of the layer responsible for the ~8–30 m diameter pedestal craters. Degraded and partially filled craters are also observed, which is consistent with the removal of a surface layer. On the basis of the ~12.5 Ma age of the ejecta, and the superposition of the pedestal craters, deposition of the pedestal substrate and formation of the pedestal craters by preferential removal of the intercrater material must post-date the ~12.5 Ma ejecta deposit.

Could the pedestal craters be substantially younger than this age? The extremely small surface areas of the pedestals considered here prevent their analysis using conventional crater retention age techniques to count superposed craters and derive ages as has been done for larger pedestal craters (e.g., Kadish et al., 2010b). However, the crater-size frequency distribution represented by the population of pedestal craters themselves (Fig. 4B) provides information on the timescale of their formation, but does not constrain the exact temporal occurrence of this period. These data suggest that the pedestal craters formed during an interval or intervals that post-dated the ~12.5 Ma ejecta unit and collectively lasted at least 600 kyr, the “age” represented by the portion of superposed impact craters that are pedestal craters. Of course, the pedestal craters could have formed over a singular ~600-kyr period, or over a set of shorter, recurring intervals when episodic ice deposits were present.

## 3. Discussion

The craters described here (Fig. 3) exhibit morphological attributes, such as pedestal extent, and terminal scarp, commonly used to define pedestal craters (Barlow et al., 2000; Kadish et al., 2009; Wrobel et al., 2006). Higher latitude pedestal craters in the southern hemisphere are characterized by pedestals that are tens of meters (mean = 20.4 m, median = 35.0 m) thick in which the crater is perched (the crater does not typically penetrate beyond the pedestal substrate) (Kadish et al., 2010a). In contrast, these decameter-scale pedestal craters penetrate through the pedestal substrate and are similar in this fashion to excess ejecta craters (Black and Stewart, 2008). Given their uniquely small size and low latitude (23° S), what is the composition and origin of the substrate for these pedestal craters?