

LUNAR MENISCUS HOLLOWES. P. J. Stooke¹, ¹Department of Geography and Centre for Planetary Science and Exploration, University of Western Ontario, London, Ontario, Canada N6A 5C2. pjstooke@uwo.ca.

Introduction. Ina, or D-Caldera (Site 1 in Table 1), was found by Ewen Whitaker in Apollo 15 images [1]. Similar but smaller features are seen in Hyginus crater (Site 2) [2, plate 161b] and near Arago in Mare Tranquillitatis (Site 10) [2, plate 194d]. They may be caused by release of volatiles through the regolith, the volatiles being residual volcanic gases or accumulating radiogenic gas, probably argon. The venting gas would blow regolith away to form a depression. The depressions are delineated by very sharply defined boundaries, convex upwards, possibly formed by late-stage collapse of partially gas-supported (fluidized) regolith in a short-lived flow back towards the depression. The distinctive boundary, resembling a liquid meniscus, inspires the name ‘meniscus hollows’ for these unusual features. Some hollows contain internal ‘islands’ of material similar to the surrounding plains, suggesting the hollows are not kipukas. Similar features are common on Mercury [3].

New observations. LROC images allow searches for many more examples, facilitated by the Quickmap interface. So far 27 locations, some with many individual hollows, have been identified (Table 1). Some (*e.g.* sites 6 or 7) are obvious, whereas others (*e.g.* sites 11 or 16) are uncertain identifications, easy to confuse with widespread bright blocky deposits on slopes and ridges. A cluster of possibly similar features near Rimae Prinz (Site 12), with many narrow bright-rimmed depressions but no ‘meniscus’, is not yet seen at sufficient resolution to be certain. Several marginal identifications can be made just north of Rima Bode (Site 11) in a pyroclastic (dark mantle) deposit. Are they poorly developed, or easily degraded in dark mantle materials, or just unrelated bright markings? A small example (Site 13) is seen on the south rim of a small vent south of Brayley D in a major volcanic region in southwest Imbrium, with other possible features all around that vent. An additional site near Secchi X [2] has not yet been observed by LROC-NAC but many small hollows are seen to its west and south (sites 18-23), adjacent to small dark volcanic hills.

Larger groups. The largest group of meniscus hollows, single or in clusters, have been found in Mare Tranquillitatis (Sites 3-9). Most are on the open mare surface between the craters Ross, Arago and Sosigenes, but two clusters occupy special locations. One cluster (Site 8) is on the floor of an elongated collapse depression east of Sosigenes, a site resembling Hyginus in geological context.

Table 1. Lunar Meniscus Hollows

Site	Location	Image
1	18.65° N, 5.30° E (Ina)	M104483493RC, LC
2	7.73° N, 6.35° E (floor of Hyginus)	M104476560LC, LO5-095-H1
3	8.31° N, 21.60° E (Mare Tranquillitatis, S of Ross H)	M142123174LC
4	8.89° N, 21.50° E (Mare Tranquillitatis, S of Ross H)	M139768545RC
5	10.31° N, 21.36° E (Mare Tranquillitatis, W of Ross H)	M106741119RC
6	10.77° N, 20.52° E (Mare Tranquillitatis, E of Maclear)	M150382358LC
7	9.54° N, 20.22° E (Mare Tranquillitatis, S of Maclear)	M162175239RC, LC
8	8.32° N, 19.39° E (Mare Tranquillitatis, on floor of depression)	M152750200RC, LC
9	8.67° N, 17.51° E (Mare Tranquillitatis, on floor of Sosigenes)	M155118645RC, LC
10	4.10° N, 21.21° E (Mare Tranquillitatis, S of Arago)	LO2-055-H2
11	13.08° N, 356.24° E (north of Rima Bode)	M126955161LC
12	26.79° N, 317.04° E (Rimae Prinz, west of Ivan)	M104798204LC, LO5-189-H1
13	19.15° N, 327.42° E (Mare Imbrium, S of Brayley D)	M144836594RC, LC
14	24.49° N, 8.13° E (Mare Serenitatis, W of Aratus D)	M150464022LC
15	24.36° N, 8.12° E (Mare Serenitatis, W of Aratus D)	M150464022LC
16	24.54° N, 8.06° E (Mare Serenitatis, W of Aratus D)	M104469044RC
17	24.76° N, 8.02° E (Mare Serenitatis, W of Aratus D)	M104469044RC
18	0.29° S, 42.80° E (Mare Fecunditatis near Secchi X)	M119571034RC
19	0.35° S, 42.80° E (Mare Fecunditatis near Secchi X)	M119571034RC
20	0.32° S, 42.81° E (Mare Fecunditatis near Secchi X)	M119571034RC
21	2.06° S, 43.52° E (Mare Fecunditatis near Secchi X)	M121925686RC

22	2.12° S, 43.53° E (Mare Fecunditatis near Secchi X)	M121925686RC
23	1.99° S, 43.41° E (Mare Fecunditatis near Secchi X)	M108951277RC
24	14.92° N, 326.30° E (Oceanus Procellarum, W of Tobias Mayer)	M150742008RC
25	14.61° N, 326.03° E (Oceanus Procellarum, W of Tobias Mayer)	M129513426RC, M107099550LC
26	14.50° N, 326.28° E (Oceanus Procellarum, W of Tobias Mayer)	M150742008RC
27	14.80° N, 326.14° E (Oceanus Procellarum, W of Tobias Mayer)	M129513426LC

The other cluster is on the floor of Sosigenes itself (Site 9). Another group of these features occurs north of Sulpicius Gallus in Mare Serenitatis (Sites 14-17). The LROC images and coordinates are listed below and images of each are shown in Figure 1. Often only part of the cluster is shown. Ina is the largest hollow, about 3 km across. Many others are only 50 to 100 m across. Another significant new grouping surrounds an old volcanic source west of Tobias Mayer (sites 24-27). None have yet been identified in the Marius Hills or Aristarchus Plateau. The common association with volcanic areas suggests residual volatiles are the cause rather than radiogenic argon.

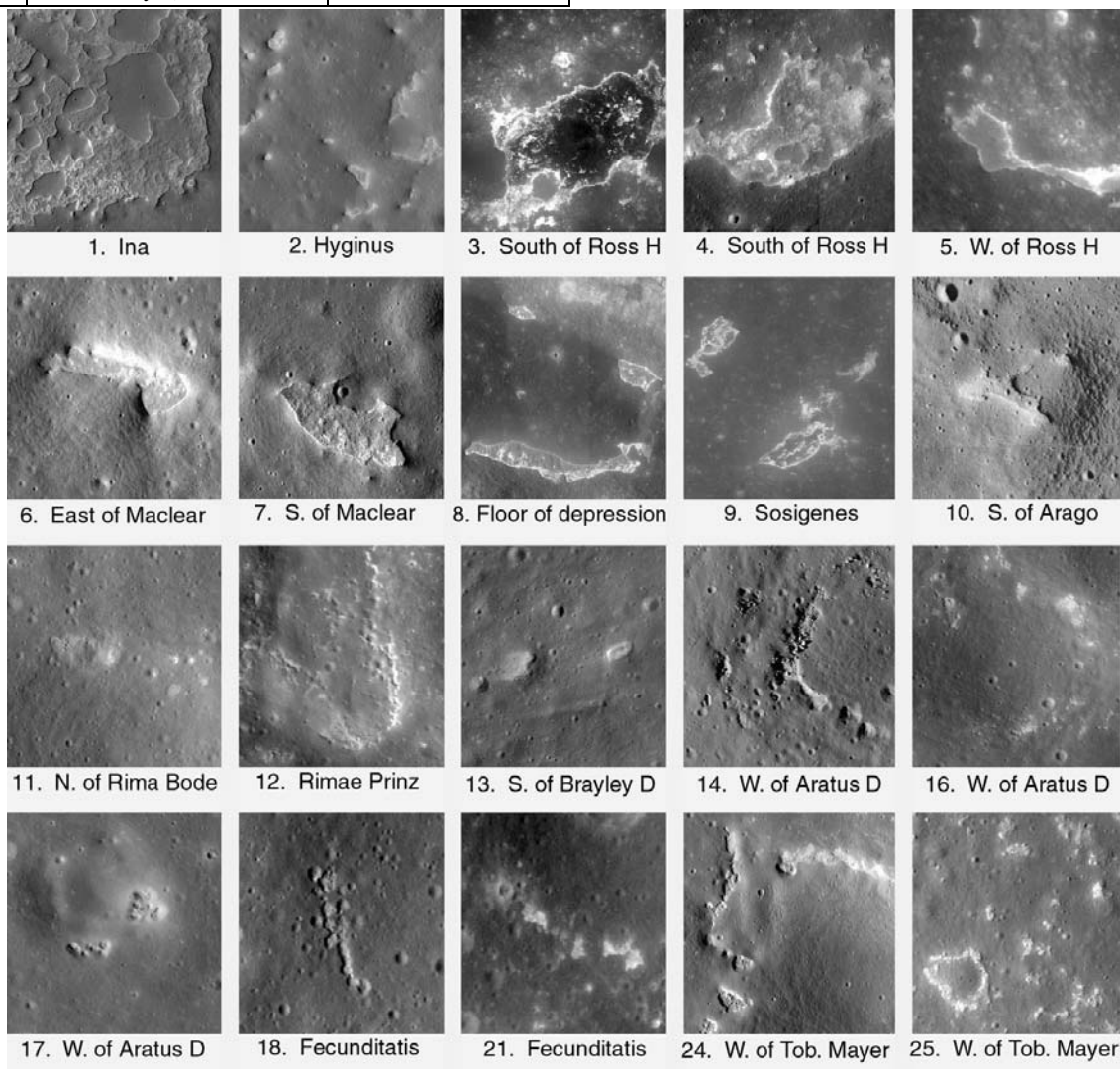


Figure 1. Twenty Lunar Meniscus Hollows. Scales vary, image widths are between 300 and 1000 m, approximately.

References. [1] Whitaker E., 1972. *Apollo 15 Prelim. Sci. Rep.*, NASA SP-289, p. 25-84 to 25-85. [2] Schultz, P., 1976. *Moon Morphology*. U. Texas Press. [3] Blewett, D. *et al.*, *Science* **333**, 1856 (2011).