DISTRIBUTION AND CHRONOSTRATIGRAPHY OF ASYMMETRIC SECONDARY CRATERS IN THE NECTARIS BASIN. W. A. Ambrose[1], [1]Bureau of Economic Geology, The University of Texas at Austin, University Station, Box X, Austin, TX 78713-8924, william.ambrose@beg.utexas.edu.

Introduction: The Nectaris Basin is an 820-km-diameter, multiring basin formed by an impact ca. 3.98 ± 0.03 Ga [1]. The basin rings are best preserved southwestward and poorly preserved toward the northeast (Fig. 1). The basin contains several well-preserved examples of radially distributed, asymmetric secondary craters, as well as genetically associated scours and crater chains. These asymmetric secondary craters have polygonal outlines and narrow rims, range in diameter from 10 to 35 km, and are shallow floored (commonly <1.5 km deep). Many are teardrop shaped, reflecting low-angle impacts; similar morphologies for low-angle impacts have been demonstrated experimentally [2, 3]. The trajectory and source area of these types of secondary craters can be inferred from the orientation of their teardrop-shaped rims, which point away from impact sites.

Recognition Criteria: Asymmetric secondary craters in the Nectaris Basin are differentiated from morphologically similar, primary craters by shallow floors; lack of slumps that produce asymmetry in small, complex, main-sequence craters; moderate to high levels of degradation; long axis orientation radially from the basin center; and association with scours and crater chains.

Asymmetric outline and shallow floors. Ballistic ejecta from lunar basins are inferred to have been expelled in a wide range of angles, with many at an angle of 45° ± 10° [4]. Oblique primary impacts also change the distribution of ejecta angles and increase the potential for low-angle impacts from secondaries [5, 6]. Examples include Abulfeda D and Andel E, 750 and 660 km, respectively, from the Nectaris Basin center (Fig. 2). Abulfeda D has a minor-axis diameter of 17 km and a major-axis diameter of 21 km, whereas Andel E varies in diameter from 8.5 to 12.5 km. Both craters are shallow (<1.0 km) and have teardrop-shaped rims oriented westward, radially away from the Nectaris Basin. Asymmetric secondaries in the Nectaris Basin are distinguished from morphologically similar, main-sequence craters, such as Bohnenberger A and Gaudibert A, which have shallow floors owing to lava floor-flooding.

Rim structure. Minor asymmetry in small, complex, main-sequence lunar craters is documented for many examples [7, 8]. Mädler and Fracastorius B in the Nectaris Basin are interpreted to have undergone postimpact, rim subsidence. In contrast, asymmetric secondaries such as Alphonsus B (Fig. 3) are differentiated from these small, complex craters by narrow rims and a lack of significant slumps.

Degradation. Secondary craters are inferred to exhibit similar levels of degradation with genetically associated impact basins. For example, Abulfeda D and Andel E, both inferred to be asymmetric secondaries associated with the Nectaris impact event, are degraded, having smooth rims and cratering density values of 0.011 and 0.006 impacts/km^2, respectively, by craters with diameters ≥0.5 km (Fig. 2).

Chronostratigraphy: Asymmetric secondaries associated with lunar basins are unique morphological features that can be used to constrain estimated ages of overlapped, extrabasinal landforms, such as other craters, scarps, and ejecta from other basins. For example, Alphonsus B, a teardrop-shaped crater west of Abulfeda D, overlaps the outer, east rim of Alphonsus (Fig. 3), suggesting that Alphonsus may be Pre-Nectarian, older than previously interpreted [9, 10]. The long axis of Alphonsus B is oriented radially (azimuth 002º) toward the center of the Nectaris Basin, consistent with an origin as a secondary crater. Other examples include Weinek G (located in Fig. 1), a degraded, 13-km-diameter crater in the southeast part of the Nectaris Basin. Weinek G is interpreted to be Pre-Nectarian, being overlapped by a 50-km-long, northwest-trending (azimuth 120º) chain of overlapping secondary craters oriented radially from the center of the Nectaris Basin. Nine other asymmetric secondaries and eleven crater chains and scour features are also documented in the Nectaris Basin (Fig. 1).

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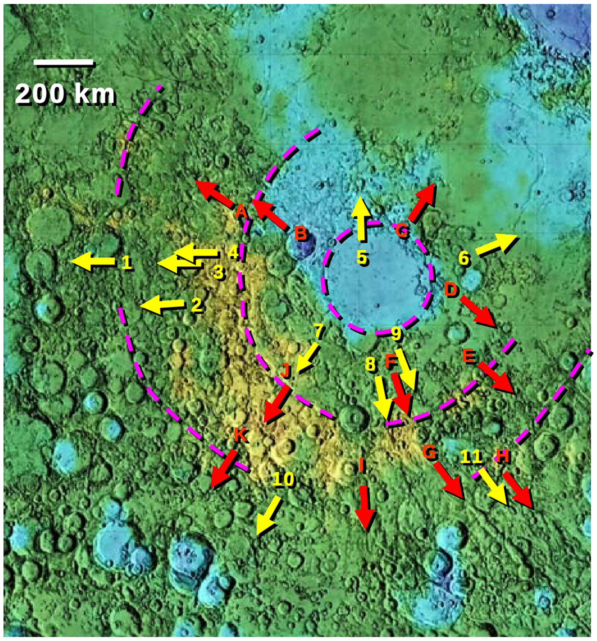

Figure 1. Lidar map of the Nectaris Basin, with asymmetric secondary craters indicated by yellow arrows, aligned along major axes of craters and pointing toward beaked rim. Scours and crater chains are shown by red arrows. Major basin rings, inferred from scarps and concentric, topographically positive features, are shown as dashed purple lines. Asymmetric secondaries: 1—Alphonsus B, 2—Airy G, 3—Abulfeda D, 4—Andel E, 5—Isidorus B, 6—Goclenius UC, 7—Polybius T, 8—Piccolomini I, 9—Crater adjacent to Weinek G, 10—Nicolai Z, 11—Crater southeast of Rheita. Scours and crater chains and valleys: A—Scour northwest of Taylor A, B—Crater chain near Zöllner I, C—Scour east of Lubbock, D—Scour south of Biot B, E—Vallis Snellius, F— Crater chain north of Neander, G—Vallis Rheita, H—Scour east of Vallis Rheita, I—Scour north of Janssen B, J—Scour north of Zagut, K—Crater chain southeast of Gemma Frisius. Data source [11].

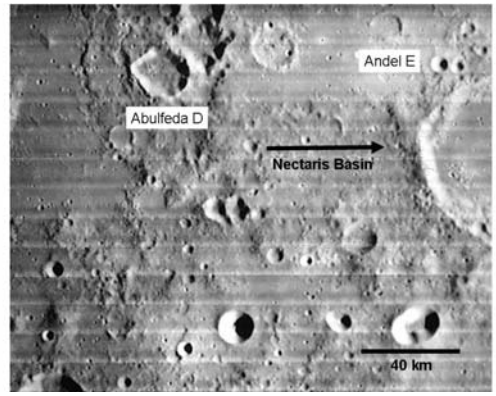

Figure 2. Abulfeda D and Andel E, indicated as features 3 and 4, respectively, on Fig. 1. Modified from Lunar Orbiter 4 Photograph LO-IV-096 H2.

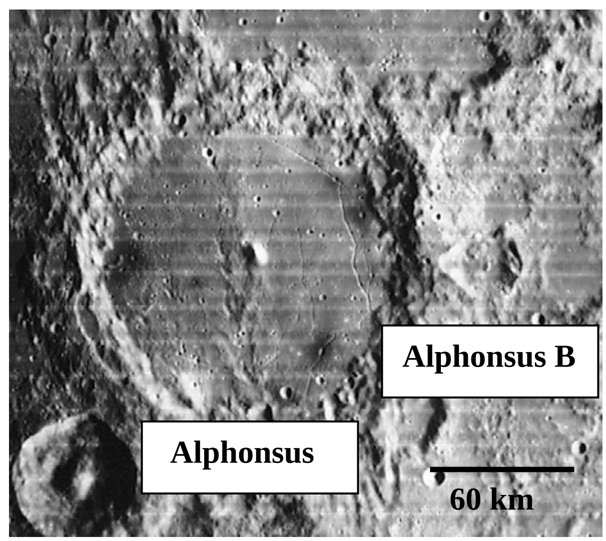

Figure 3. Alphonsus and Alphonsus B, indicated as feature 1 on Fig. 1. Alphonsus B is an asymmetric, shallow-floored, teardrop-shaped crater that overlaps the east rim of Alphonsus. Modified from Lunar Orbiter 4 Photograph LO-IV-108-H2.