ARE NOACHIAN-AGE RIDGED PLAINS (*Nplr*) ACTUALLY EARLY HESPERIAN IN AGE? H. V. Frey, C. E. Doudnikoff and A. M. Mongeon, Geodynamics Branch, Goddard Space Flight Center, Greenbelt MD 20771

Ridged Plains of Noachian Age?

The prominant ridged plains of Lunae Planum, Coprates, Hesperia Planum and elsewhere are generally considered to have erupted in the Early Hesperian (1,2) and are generally taken to define the base of that stratigraphic system (3). These plains are widespread, covering over 4 x 10^6 km^2 in western Mars alone (1) and are broad, planar surfaces with some flow lobes and parallel, linear to sinuous ridges similar to lunar mare ridges with a spacing of 30 to 70 km. The general interpretation is that the ridged plains (unit *Hr*) are due to relatively rapid eruptions of low viscosity lavas (1,2), and their occurance at the base of the Hesperian represents a major volcanic episode in martian history (3).

In some areas these plains are gradational with another ridged plains unit, mapped as *Nplr*. The ridges of these apparently Noachian-age plains are generally further apart with rougher, more heavily cratered inter-ridge areas (1,2). *Nplr* terrains are widely distributed in both hemispheres of Mars but cover much less area than the more common *Hr* unit. The type area in Memnonia lies southwest of Tharsis in heavily cratered terrain (Npl_1, Npl_2). Other major occurances are further south in Sirenum, between the Argyre and Hellas Basins in Noachis, in the southern portion of Cimmeria Terra and in the northeastern portion of Arabia (1,2). The Noachis and Cimmeria outcrops are distributed roughly concentrically about the Hellas impact basin at approximately 1 and 2 basin diameters, respectively.

The stratigraphic position of these apparently older ridged plains is **Middle Noachian**; in the current geologic maps the unit does not extend into the Upper Noachian and appears temporally unrelated to the more common Hesperian ridged plains (*Hr*) even though these two units are sometimes gradational. The assignment of stratigraphic position is based on superposition relationships and total crater counts; the high density of impact craters on *Nplr* would certainly suggest a Noachian age.

But total crater counts can be misleading: if multiple resurfacing or other crater depopulation events occur and successfully compete with crater production, a given terrain may have an apparently young total crater age even though very old surfaces remain partially exposed in the form of very large craters. Inefficient resurfacing events allow older surfaces to show through and give old crater retention ages based on total crater counts, which may not accurately reflect the age of the major terrain unit. In this paper we examine whether or not the *Nplr* units in Memnonia and Argyre truly represent ridged plains volcanism of Noachian age or are simply areas of younger (Early Hesperian age) volcanism which failed to bury older craters and therefore have a greater total crater age than really applies to the ridged plains portion of those terrains.

Resurfacing in Memnonia and Argyre

We used the Neukum and Hiller (4) technique to determine the number of preserved crater retention surfaces in the Memnonia and Argyre regions where Scott and Tanaka (1) show *Nplr* units to be common. The Memnonia outcrops are the type example of this unit, and we subdivided the study area in MC 16 into two broad units: cratered terrain *Npl* (mostly Npl_1 and Npl_2) and the ridged plains *Nplr*. Our mapping is similar to but not identical with that previously done (1). We counted craters larger than 3 km in diameter and plotted cumulative frequency curves for each terrain unit, then broke these curves into separate branches where they departed from a standard production curve (4, 5). This departure is interpreted to be due to resurfacing, and breaking the curves into separate branches allows determination of the crater retention age of each post-depopulation "surface" independent of previous history (the survivors are subtracted and remaining craters compared independently to the crater production curve). Table 1 summarizes the results for cratered terrain (*Npl*) in Memnonia and for ridged plains (Nplr) in both Memnonia and Argyre, and compares these with similar results obtained by us for Tempe

Terra (6) and Lunae Planum (the type area for the Lunae Planum Age [LPA] ridged plains [*Hr*] resurfacing).

In Lunae Planum no craters larger than 50 km exist within the ridged plains; in Memnonia and Argyre there are craters as large as 117 and 100 km that survive in the *Nplr* unit. The population of old, large craters contributes to the total crater counts which suggest the *Nplr* unit is of Noachian age. We find the cumulative frequency curves for the ridged plains in Argyre/Memnonia can be broken into four branches which have remarkably similar crater retention ages N(1): an oldest branch ~[121,000/115,000], a branch with N(1) = [80,200/76,500], a "Lunae Planum Age" branch at [28,100/22,100], and a still younger branch at N(1) = [6700/6200]. Note that the Argyre ages for *Nplr* are consistently slightly older. These ages compare with resurfacing ages for the cratered terrain *Npl* in Memnonia of N(1) = [226,900], [76,000], [27,900], and [6300]. For all but the oldest (and most poorly determined) branch, the crater retention ages for the different branches are extremely similar from one area to the next.

The craters which determine the ridged plains resurfacing age (those superimposed on the ridges as opposed to showing through the plains) define the N(1) = [25,000 +/- 3000] age branch for both Memnonia and Argyre. This age is nearly identical (with the precision this technique affords) with the oldest branch we find for Lunae Planum: N(1) = [25,700], even though the craters which define this age branch (10-20 km in Argyre, 8-15 km in Memnonia) are significantly smaller than in Lunae Planum (25-50 km). This implies that the thickness of the *Nplr* ridged plains in Argyre and Memnonia is significantly less than we estimate (4,5) for Lunae Planum (350- 600 m). This reduced thickness is what allows the older craters to show through, preserving the older crater retention surfaces at N(1) = [78,000 +/- 2000] and [118,000 +/- 3000]. These older preserved craters contribute to the high total crater counts that suggested the *Nplr* were of Noachian age.

We suggest that for these two areas at least the *Nplr* ridged plains are the same age as those (*Hr*) in Lunae Planum, Tempe and elsewhere: N(1) = [25,000 +/- 3000]. If this conclusion holds in general for the other outcrops of those units mapped as *Nplr*, it may imply that the eruption of ridged plains volcanism was more restricted in time than previously thought. This would have interesting implications for models of the thermal history of Mars, and would make the ridged plains even more important as a stratigraphic marker in martian history.

Table 1. Resurfacing Ages for Memnonia and Argyre

AREA	UNIT	CRATER RETENTION AGE N(1)			
Memnonia	Npl	226,858	75,980	27,866	6,343
Memnonia	Nplr	115,221	76,445	22,062	6,223
Argyre	Nplr	121,300	80,200	28,100	6,700
Lunae Planum	Hr	--	--	25,700	10,100
Tempe	Hr	--	--	22,100	6,500

References: (1) Scott, D. H. and K. L. Tanaka, Geol. Map Western Equatorial Region of Mars, USGS Map I-1802-A, 1986. (2) Greeley, R. and J. E. Guest, Geol. Map Eastern Equatorial Region of Mars, USGS Map I-1802-B, 1987. (3) Tanaka, K. L., Proceed. LPSC 17th, JGR 91, E139-E158, 1986. (4) Neukum, G. and K. Hiller, JGR 86, 3097-3121, 1981. (5) Frey, H., A. M. Semeniuk, J. A. Semeniuk and S. Tokarcik, Proceed. LPSC 18th, 679-699, 1988. (6) Frey, H. and T. D. Grant, submitted to JGR, 1989.