GEOLOGY AND MORPHOMETRY OF LARGE IMPACT CRATERS OF VENUS; A.T.Basilevsky(1), B.A.Ivanov(2), P.G.Ford(3) and C.M.Weitz(4); (1)Vernadsky Institute, Moscow, 117975, Russia; (2)Institute of Dynamics of Geospheres, Moscow, Russia; (3)MIT, Cambridge, MA 02139; (4)Brown University, Providence, R.I., 02912.

SUMMARY. Photogeologic analysis of the 3 largest craters on Venus (Mead, Isabella and Meitner) showed a presence of wrinkle ridges on the crater's floor. It seems to contradict the crater relaxation model which predicts the crater floor uprise. The precise subsidence of the uplifted blocks of dense mantle material beneath the crater center.

INTRODUCTION. The low resurfacing rate typical for the last 0.5 b.y. of Venus' history and global coverage of this planet by the Magellan high resolution radar survey make Venus an interesting place to study impact craters formed by projectiles large enough to penetrate through the planet's massive atmosphere. Our study is concentrated on the analysis of SAR imagery and altimetry data for the largest four impact craters of Venus: Mead, D=280 km; Isabella, 175 km; Meitner, 150 km; Klenova, 140 km. We used in our analysis full resolution mosaics and altimetry data specially processed to distinguish separate nearby echoes placed in the nadir zone surfaces with different elevations.

PHOTOGEOLOGIC DESCRIPTION. Crater Mead (12.5° N, 57.2° E) is a double-ring basin among the plains with wrinkle ridges (Pwr). Remnants of densely fractured terrain (Pdf) and ridge belts (RB) are observed among Pwr. Both Pdf and RB are embayed by Pwr. The outer ring of the Mead basin is the crater rim consisting of degraded remnants of knobby crater ejecta alternating with plains, areas of which have wrinkle ridges, and areas which seem to be covered with aeolian debris mantle hiding the wrinkle ridges. Remnants of the Mead ejecta look superimposed on the said remnants of ridge belts (11.5° N, 58.7° E). The inner ring of the basin (D=180 km) is an inward-looking scarp of sinuous outline. The annular area between the outer and inner rings looks quite similar to the rim area: patches of plains alternating with knobby ejecta. In some cases plains of the crater rim merge into plains of the inter-ring annulus (11.8° N, 56.1° E). Wrinkle ridges are seen at some places of the inter-ring plains too. In the western part of the inter-ring annulus Pwr look as if they are embaying the ejecta patches. The basin floor inside the circle scarp is more radar-bright than the inter-ring and rim area plains. The scarp cuts the terrace of the inter-ring annulus and, in turn, looks as though embayed by the said brighter plains of the basin floor. The latter in its north-central part is complicated by sinuous lineaments, at least part of which are wrinkle ridges, but they are shorter, more narrow and more irregularly oriented than the wrinkle ridges of the surrounding plains. These observations provide the possibility of deducing a scenario of geologic history of the crater Mead area: The Mead basin was superposed on the plains with ridge belts (RB). Then younger plains later deformed by wrinkle ridges (Pwr) were emplaced outside the crater, in the inter-ring annulus, and probably on the basin floor. Then the inner scarp was formed and the brighter plains were emplaced in the depression outcircled by this scarp. It is not clear whether all wrinkle ridges of this area were emplaced in one episode or in two separate episodes, first, wrinkle ridges of the regional network and inter-ring annulus, and, second, the wrinkle ridges of the basin floor.

Crater Isabella (29.7° S, 204.1° E) is a double-ring basin superimposed on the plains with wrinkle ridges (Pwr). The outer ring is the crater rim, mostly covered with knobby ejecta. In the southern sector of the crater the blocky material of the crater floor merges with the knobby material of the crater rim. This part of the ejecta is a source of two extended outflows. The central part of the basin is outlined by the annulus of lineaments (fractures?) which forms the inner ring of about 80 km in diameter. Between the lineaments circle and the outer rim there is an alternation of plains and blocky material of the primary crater floor. Inside the inner ring there are plains with a subradial system of wrinkle ridges. The latter were definitely formed after the basin excavation and emplacement of the plains of the basin floor. Meanwhile the wrinkle ridges of the regional network on the plains outside crater Isabella were formed before this crater was emplaced. This is proved by the overlapping of the wrinkle ridges by the crater outflow (33° S, 205° E) and by the intrusion...
of the outflow material into the fracture which belongs to the system disrupting wrinkle ridges of the regional network.

Crater Meitner (55.6° S, 321.6° E) is a double-ring basin. The outer ring is the crater rim covered with knobby ejecta. Among the ejecta there are volcanic domes, some of which look partly covered by ejecta, and some which look emplaced after the ejecta. No outflows are seen in association with crater Meitner. The inner ring (D=90 km) is an annulus of knobby terrain elevated over the basin floor. The area between the inner and outer rings is plains with knobs among them similar to those which make the inner ring. The basin floor inside the inner ring is plains with wrinkle ridges forming a concentric system on the periphery and a subradial system in the center. Small domes similar to the volcanic domes of the venusian plains are seen on the basin floor. Crater Meitner is superposed on the plains with wrinkle ridges with predominant NE trending. The wrinkle ridges are covered by the crater ejecta and in some cases show through the ejecta. In the eastern sector of the ejecta a wrinkle ridge showing through the ejecta comes very close to the inward-looking crater rim scarp with no changes in the ridge prominence and its NE trending. If the wrinkle ridges were formed after the crater the stress forming this on-rim ridge would be impossible. In the NW sector the emplacement of the ejecta seems to be controlled by the preexisting wrinkle ridges. So crater Meitner like crater Isabella has on its floor a set of wrinkle ridges formed after the crater emplacement while the wrinkle ridges of the regional network were formed in a different episode before the crater formation.

**DISCUSSION.** The presence of wrinkle ridges on the craters' floors seems to contradict the model of crater relaxation [1] predicting the crater floor uprising in this process. If this prediction was correct we would see fractures rather than ridges on the crater floor. Moreover the precise radar altimetry for the venusian craters larger than 70 km in diameter [2] did not show the evidence of the floor uprising predicted by [2]. The reason for this disagreement between the prediction and observations could be the initial state of compensation of large venusian craters which seems to be different from that supposed by [1].

It is well known from terrestrial experience that in the center of complex craters the structural uplift of rocks exists with an amplitude of D/10 relative to the initial depth [3, 4]. If we adopt the same amplitude for Venus, craters with diameters 150 to 300 km would have an uplift with 15 to 30 km amplitude. So for the largest craters the significant uplift of the dense mantle material might exist just after a crater formation. Geophysical evidence of the mantle uplift have been analyzed for lunar basins by Bratt et al. [5]. According to [5] the mantle uplift subsides down with time. If this style of relaxation is the case for Venus, one may propose the model of initially overcompensated craters with the downward subsiding of the mantle uplift (and the crater floor) due to viscous relaxation. In this case the maximum depth of a crater may increase, not decrease, with geologic time.

**CONCLUSION.** The Magellan specially processed altimetry profiles [2] demonstrate the relatively small central depression at the flat floor of some of the Venusian craters larger 70 km. These depressions may be a manifestation of the "downward mantle relaxation." If so: (i) a viscous relaxation model for initially overcompensated craters may give an additional possibility of estimating rheological properties of Venus rock; and (ii), the surface layer of these craters' floor should be affected by compression rather than extension.