Introduction: We are constructing the 1:10M geologic map of Niobe Planitia (0-57N/60-180E, 1-2467) with the aim of establish the geologic history of this region, and test existing hypotheses for the geodynamic evolution of Venus. The Niobe Map Area (NMA) contains a rich assemblage of basement (crustal plateaus and lowland tessera inliers), deformation belts, and plains materials (shield plains, volcanic and corona-related materials and large expanses of apparently undivided plain materials).

We present the result of the complete structural map of the NMA and describe the regional-scale patterns, local modifications of these regional patterns, and the effect of large tectonomagmatic structures on these regional fractures suites. In this abstract we limited discussion to lowland structures; tessera terrain structure are not discussed herein. Recognition of lowland structures and their interaction with volcanic materials is fundamental for the delineation of lowland material units and the establishment of a geologic history at regional scale [1]. We also present the initial delineation of material units in the map area.

Data and methods: Geologic analysis was carried out using: (1) NASA’s Magellan full-resolution SAR data (left- and right-looking and in both normal and inverted modes) [2]; (2) Magellan altimetry; and (3) synthetic stereo images constructed after using NIH-Image macros developed by Duncan Young.

Data visualization and geologic mapping was conducted using Adobe Illustrator™ for mapping with linked NASA Magellan SAR and altimetry data, MA-Publisher™ to scale and place georeferenced raster datasets, and ArcGIS™ and ArcGlobe™ for compilation, analysis and final map production. Geologic mapping has been conducted using full-resolution data to constrain the nature of the structures and the crosscutting relationship between structures and material units, and later translated to the 1:10M mapping scale.

Lowland Structures in the NMA: Structures in the volcanic plains of the NMA are divided into two groups: (a) Regional structures distributed across huge expanses of the NMA; and (b) local structures that are both spatially and genetically related to individual tectonomagmatic features.

Regional contractional deformation suites

Folds. Broad folds deform some local basal units of the volcanic plains. These folds occur in areas of concentrated deformation in two areas: NNW-trending folds within Lenkechen and Unelanuhi Dorsa, cutting basal materials in Akhtamar Planitia, western NMA; NNE- trending folds cutting basal materials of eastern NMA (Llorona, Vellamo and Atalanta planitiae).

Wrinkle ridges. We recognize four different suites of wrinkle ridges: (a) regional suites; (b) local inversion structures; (c) local suites concentric to individual corona; (d) wrinkle ridge trends that parallel adjacent tectonomagmatic features and deformation belts. The circum-Artemis trend (a), the most regionally extensive suite in the NMA, marks a suite of wrinkle ridges that extend beyond the map area, and define a region >13,000 km in diameter around Artemis Chasma in the Aphrodite Terra Map Area [3]. Some wrinkle ridges of this regional trend display trends parallel to large tectonomagmatic centers and deformation belts (d) (i.e. folds); in eastern NMA wrinkle ridges adjacent to deformation belts parallel local deformation belts trends (e.g. deformation belts in Atalanta Planitia and Vellamo Plamitia), nearly orthogonal to the main circum-Artemis regional trend. This relationship indicates that the deformation belts likely predated formation of the Artemis-suite of wrinkle ridges. In western NMA folds in the basal plain materials nearly parallel wrinkle ridge trends, thus temporal relations are undefined.

In central NMA local N-trending wrinkle ridges show clear evidence of being inversion structures; that is, wrinkle ridges occur along strike with individual fractures locally buried by lava flow material. These relationships indicate that N-trending fractures formed first, followed by local burial, and finally shortening resulting in the formation of inversion structures.

In Leda Planitia wrinkle ridges define a reticulate pattern similar to that present in the basement materials and in the volcanic materials that postdate these basement materials, but the existence of reactivation has not yet clearly established.

Regional extensional deformation suites

Regional fractures. We identified different fracture suites of regional extent based on trend, spacing and temporal relations with volcanic materials.

Suite A. NNW-trending fractures mark the oldest fracture suite in the central part of the NMA, and in Leda Planitia this fracture trend also deforms the lower plain materials, due to reactivation of buried structures.
This trend is the principal direction of ribbon structures that characterize earlier formed, underlying tessera terrain in central NMA. Locally it is clear that the NNW-fracture suite results from reactivation of local basement structures, which were covered by thin flows or discontinuous materials from small shield clustering (shield material or shield plains); the trend of the shallowly buried structures is apparent in high resolution SAR. The trend and fracture spacing of this fracture suite is constant across a great expanse of the central NMA indicating that basement structures/heterogeneity played a strong role in fracture trend.

Suite B. The NNE-trending fracture trend occurs in Leda Planitia, where the suite is best developed, and locally within central NMA. Within Leda Planitia the fractures parallel the trend of underlying ribbon structures of Dekla Tessera (which parallel ribbon tessera fold trends to the south in northern Tellus Regio). Within Leda Planitia the fractures appear to be reactivation structures, as the case for suite A fractures. In central NMA, however, fractures trending are more widely spaced, and there is no evidence of underlying structural trends that might serve as loci for reactivation. Within Leda Planitia wrinkle ridges define a reticulate pattern that likely occurs due to two near-orthogonal fracture suites related to underlying tessera terrain fabric trends of Dekla Tesserae and Tellus Regio. The consistent spacing of both suites suggest a control by underlying structures or the presence of a regional rheological discontinuity beneath the relatively thin cover unit.

Artemis-radial suite. A suite of regional fractures that fans across the NMA describes a huge suite of fractures radial to Artemis Chasma [3]. These fractures trend NE in the eastern NMA and trend NW in western NMA. Within central NMA these fractures trend N, and are the youngest recognized regional fractures at this location. Corona decorate this fracture suite, and they are likely temporally related; structural elements of the corona annulli both cut and are cut by fractures of this suite, suggestive of a genetic relationship as well. Portions of the Artemis-radial suite are locally reactivated to inversion wrinkle ridges within in several areas of the NMA.

Map relations indicate that Artemis-radial fractures predate formation of Kunhild and Ereshkigal Coronae in Akhtamar Planitia, which are interpreted as an extinct hot-spot [4]; thus these coronae likely post-date formation of the corona in central NMA.

Local deformation suites.

Radial fractures. Radial fracture suites occur related to large tectonomagmatic centers. These suites can extend great distances from their foci, and therefore might be useful as local temporal markers for unit delineation (i.e., Holde Corona in Atalanta Planitia and Kurukulla Mons in Till-Hanun Planitia).

In western NMA (i.e., Akhtamar Planitia) radial fracture suites connect large, otherwise isolated, tectonomagmatic centres (Hatshepsut Patera-H’uraru Corona, Uli-Ata Mons, Kaltash Corona, Kunhild Corona, Ereshkigal Corona), forming an extensive interconnected suite that is difficult to differentiate from the regional fracture suites described herein.

Concentric fractures. Concentric fracture suites that occur as annuli of individual coronae in the central NMA appear temporally related to the N-trending portion of the Artemis-radial fracture suite. Typically these coronae lack obviously flows; the lack of flows may be a function of homogenization through weathering, or these coronae did not transfer magma to the surface. Kaltash and Rosmerta Coronae, located in Aphrodite Terra, display annuli of concentric fractures and extensive flows that embay and postdate the crustal plateaus, and clearly emerged from radial corona-related fractures.

Concentric ridges. Concentric ridges form the annulus of some coronae (e.g., Iutana and Bil Coronae in eastern NMA). These coronae are the source of large traceable flows that bury extensive portions of the NMA. Similar concentric ridges in Innini Mons are interpreted as result of tectonic inversion or warping of regional stress around a hole in a plate (i.e., empty magmatic reservoir) [5]. Futher mapping of flows and materials is necessary to favor one of the working models.

Initial delineation of units and further work: The next steps in the geologic mapping of the NMA include the delineation of material units. Initial results based on units compiled from published 1:5M maps suggest a mixed style in local resurfacing with both point source volcanism (i.e., shield plains) and corona-and volcano-related units playing an important role in the evolution of the lowlands. Future work includes (a) complete delineation of material units across the NMA; (b) establishment of local geological histories where structural markers (e.g., dykes or regional structures) impose temporal constraints on the relative ages among material units; (c) testing of existing hypotheses of geodynamic evolution of Venus at the scale of the NMA map scale.