

GEOLOGIC ANALYSIS OF DEFORMATION IN THE INTERIOR OF ARTEMIS
(VENUS, 34°S, 132°E)

A THESIS
SUBMITTED TO THE FACULTY OF THE GRADUATE SCHOOL
OF THE UNIVERSITY OF MINNESOTA
BY

ROGER ALLEN BANNISTER

IN PARTIAL FULFILLMENT OF THE REQUIREMENTS
FOR THE DEGREE OF
MASTER OF SCIENCE

MAY 2006

Abstract

Artemis, an ~2600 km diameter circular feature on Venus, is the largest known circular structure on a terrestrial planet. Artemis' most distinctive feature is Artemis Chasma, a ~25-200 km wide, ~1-2 km deep, ~2100 km diameter circular trough surrounding an interior topographic high. Artemis defies geomorphic classification. Artemis dwarfs Venus' largest impact crater, 270 km diameter Mead. Although topographically Artemis resembles some coronae, Artemis is an order of magnitude larger than the average corona and is more than twice the size of the next largest corona, Heng-O. Artemis' resembles volcanic rises and crustal plateaus in planform, yet differs greatly in topography. Detailed geologic mapping of the interior of Artemis reveals a regionally extensive penetrative tectonic fabric with a generally consistent northeast trend and average wavelength of $\sim 520 \pm 125$ m. The interior records spatially and temporally overlapping development of four centers of tectonomagmatic activity, which each formed broadly contemporaneously with Artemis Chasma. According to four published hypotheses, Artemis represents: 1) a zone of northwest directed convergence and subduction; 2) a composite structure with the interior marking the exposure of ductily deformed deep crustal rocks analogous to a metamorphic core complex; 3) the surface expression of a bolide impact; or 4) the surface expression of a mantle plume. None of the hypotheses address the penetrative fabric. The plume hypothesis is favored as the most consistent with geologic observations; however, it requires modification to explain the penetrative fabric.

Table of Contents

| | |
|---|----|
| Introduction..... | 1 |
| Background..... | 3 |
| Venus | 3 |
| NASA Magellan Mission..... | 4 |
| Artemis Chasma and Artemis Corona | 4 |
| Previous Work | 5 |
| Data..... | 9 |
| Magellan Datasets..... | 9 |
| Obtaining Data..... | 10 |
| Methods..... | 12 |
| Interpreting Radar Imagery..... | 12 |
| Visualization Techniques..... | 12 |
| Mapping Equipment and Cartography..... | 14 |
| Mapping Criteria..... | 15 |
| Observations | 18 |
| Description of map units..... | 18 |
| Artemis Chasma and Exterior Deformation | 21 |
| Tectonomagmatic Centers | 22 |
| Penetrative Fabric | 24 |
| Implications of the Penetrative Fabric | 28 |
| Structure Review..... | 28 |
| Rheological ‘Thought Experiments’ | 29 |

| | |
|---|-----------------|
| From Thought Experiments to Reality | 32 |
| Geologic history | 36 |
| Evaluation of hypotheses | 40 |
| Subduction hypothesis | 40 |
| Metamorphic core complex hypothesis | 43 |
| Bolide impact hypothesis..... | 44 |
| Plume hypothesis | 46 |
| Conclusions..... | 49 |
| References..... | 50 |
| Tables | 55 |
| Figures..... | 58 |
| Plates | see attached CD |