Chapter 9b Venus

Spacecraft

Surface
- Ishtar Terra
- Aphrodite Terra

Cratering
Volcanic Activity

✓ Volcanoes
✓ Volcanism today
✓ Lava Domes
✓ Coronae
✓ Arachnoids
✓ Tesserae
✓ Resurfacing

Major Spacecraft to Venus
1968–2006

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1967 - 78: Venera 4 -12 parachuted into the atmosphere

1982- 84 Venera 13-16 images of surface

Venera 13 survived for 127 minutes

Venera 14 survived for 57 minutes

1978 Pioneer Venus (radar Map)
The Pioneer Venus Orbiter was launched on May 20, 1978, and was inserted into orbit around Venus on December 4, 1978.

Made the first radar maps of the surface

The Pioneer mission carried a Multiprobe----one large and three small atmospheric probes.

All the entry probes survived the density of the Venusian atmosphere until impact, but only one probe survived for a significant period after impact.
1990 Magellan -
✓ Launched on 1989, arrived at Venus on 1990
✓ was inserted into a near-polar elliptical orbit

The mission
✓ Make a radar map the surface
✓ At the completion of radar mapping 98% of the surface was imaged

Ended in 1994
✓ At the completion of the mapping 98% of the surface was mapped
✓ It ended when the spacecraft was allowed to plunge into Venus’s atmosphere

2006 Venus Express (European Space Agency)

Venus Express: Launched in 2005 and arrived at Venus in 2006

Mission: study its atmosphere and its interaction with the solar wind.

Ishtar Terra
Ishtar is the prominent highland in the north, named after the Babylonian incarnation of Venus.

Aphrodite Terra
The largest continent is called Aphrodite, using the Greek word for Venus.

rolling plains almost 70% covered by gently rolling uplands, about 20% very flat lowlands

ultraviolet and infrared images
On Earth, continents are associated with the borders of tectonic plates, which drift and collide in time, giving birth to mountains and causing earthquakes.

On Venus there does not seem to be any tectonic plate activity to move and shape the surface. It seems that there is a single plate covering the whole planet.

Tesserae
Tectonic activity can take the form of tension or compression; both of which tend to produce parallel cracks or folds. Tesserae are covered with so many ridges and grooves that they appear bright in radar images.

Tesserae are areas with a lot of shortening and compression, so they hold many clues as to how Venus’ crust shifts about.

Origin of Tesserae
Compression from mantle downwelling and Extension from upwelling mantle plume

No plate tecbonics! Single Plate

Wrinkled mountain formations indicate compression and wrinkling

Lakshmi Planum
Maxwell Montes
Sacajawea
Colette
Cleopatra

large lava flows

craters

Pancake Lava Domes

This feature is called the “Tick” and is roughly 66 km across. Like the pancake domes, the ticks are broad, mostly flat features, and they often have a central pit or vent structure. The difference is that the ticks are surrounded by an array of short, radial ridges. In this case, the “head” of the tick is defined by a set of small collapse pits.

‘pancake domes’ may be 65 km across and 2-3 km high. These dome-shaped structures resulted when viscous molten rock bulged out of the ground and then retreated, leaving behind a thin, solid crust that subsequently cracked and subsided.
Coronae
- Coronae are circular raised features.
- 100s to 1000s of km across:
  - Interiors raised about 1km
  - Trough around the dome
  - Concentric cracks
- Associated with large amounts of volcanism
- Perhaps unique to Venus
- 360 Coronae identified

Possibly caused by magma plumes which have failed to break the surface.
Withdrawal of magma forms concentric fractures

Arachnoids
- Arachnoids are circular features with concentric rings and a network of fractures extending outward.
- The arachnoids range in size from approximately 50 to 230 kilometers (in diameter).
- Arachnoids are similar in form but generally smaller than coronae

May be precursor to coronae formation. The radar-bright lines extending for many kilometers might have resulted from an upwelling of magma from the interior of the planet which pushed up the surface to form "cracks."

Cratering
1) Nearly 1000 impact craters on surface of Venus
2) Terraced inner walls and central peak
3) The crater floors are smooth due to melting of crustal material

Crater Golubkina 30 kilometer (19 mile) diameter

Mead double-ringed structure.
Largest crater about 280 km across.
Crater flooded by lava.

Extensive outflow; Because of the high temperature and pressure on the impacts produce more melt than on other planets.

Multiple craters
A small projectile broke up in the atmosphere to form this crater cluster.

it is almost impossible to find craters less than two kilometres in size.

This is possibly due to the high density of the atmosphere, which pulverises smaller meteorites before they hit the ground.

Volcanoes
Maat Mons (volcano)

Young lava flows from Maat Mons

Sapas Mons (volcano)

Lava flows from Sapas Mons extend for hundreds of kilometers

Gula Mons

Heigh 8 Km

Diameter 395 Km

Maat Mons

Heigh 3 km

Diameter 276 km

variation in the concentrations of sulfur dioxide (SO$_2$) and methane (CH$_4$) in Venus' middle and upper atmosphere. One possible explanation for this was the injection of volcanic gases into the atmosphere by eruptions at Maat Mons.
Volcanism today?

1. SO, levels above the thick cloud cover fluctuates frequently---result from volcanic eruptions?

2. Probes observed suggestive radio emissions---similar effects are initiated on Earth by erupting volcanoes causing lightning discharges.

On Earth, plate tectonics and volcanism ensures that internal energy is dissipated gradually. Instead, on Venus, instabilities inside the planet build up until the whole world is engulfed in a global eruption.

As an effect the planet is resurfaced in a geologically short time, and many craters that have formed are destroyed.

The oldest craters seem not to be older than 500 million years, which may indicate that a global resurfacing has taken place in this time frame.

Venus is about 80% covered in lava plains, similar to the lunar maria, or the ocean crust of the Earth.

The average density of 10-km craters is only 15% that of the lunar maria, implying a youthful age of 500 million years or so for the terrain (compare to ocean basins on the Earth: average 100 million years).

The craters remain ‘fresh’ in appearance, seemingly until they are wiped out, rather than being gradually eroded as on the Earth.

The outflow has not been continuous: in fact, most of the outflow occurred in an episode about 500 Myr ago, with a much reduced level of activity since then.

The entire surface of Venus was resurfaced sometime in the recent geological past. The surface geology of Venus is different than the Earth because of a lack of water. Water is not lubricating the crust and there is no plate tectonics.

Instead, forces inside the planet are trying to move things around, but cannot because they are locked. The surface then explodes and globally explosive episodes happen about every half-a-billion to a billion years.