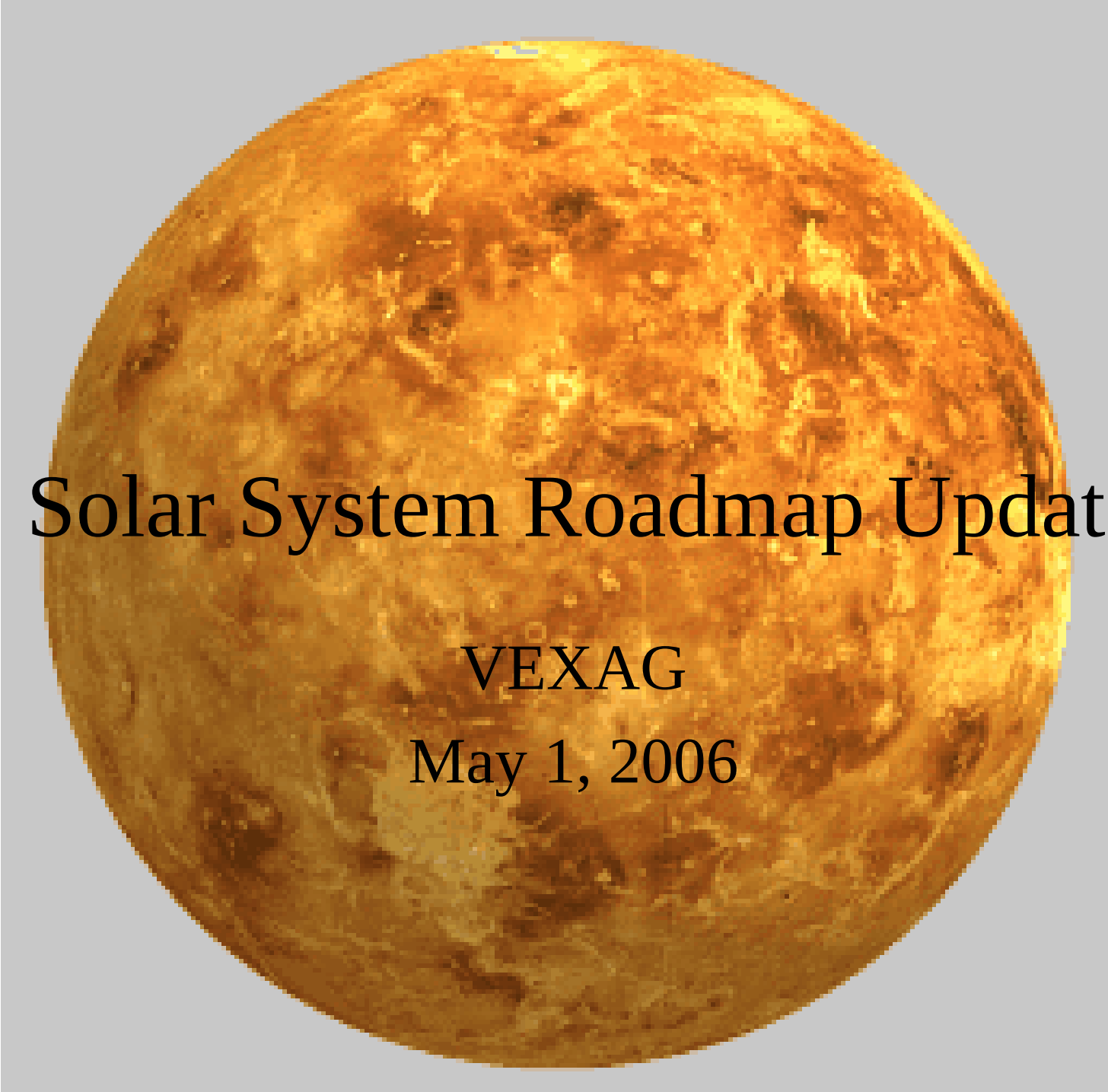
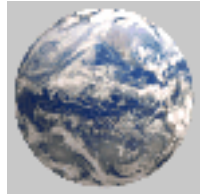


Solar System Roadmap Update

VEXAG

May 1, 2006

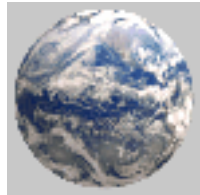
Roadmap Science



Roadmap based on five key science questions adopted in 2003 by NASA's Office of Space Science:

1. How did the sun's family of and minor bodies originate?
2. How did the solar system evolve to its current diverse state?
3. What are the characteristics of the solar system that lead to the origin of life?
4. How did life begin and evolve on Earth and has it evolved elsewhere in the solar system?
5. What are the hazards and resources in the solar system environment that will affect the extension of human presence in space?

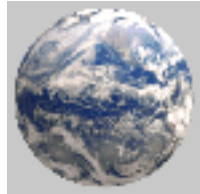
Roadmap: Unifying Theme



- *Habitability*-the ability of worlds to support life. We seek to know whether life is or was present elsewhere in the solar system, how we and our planet came to be, and what are the future prospects for terrestrial life on and off the Earth. The five scientific questions tie into this theme.

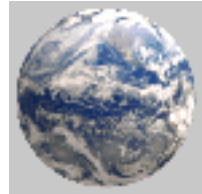
- Habitability theme can be split into three threads:
  - Habitability in planetary environments: how have specific planetary environments evolved with time, when and in what way were they habitable, and does life exist there now?
  - Habitability associated with planetary architecture: what determines the arrangement of planetary systems, what roles do the positions and masses of giant planets play in the presence of habitable planets and moons in a planetary system, and how have our own giant planets shaped the evolution of the impact hazard population in our own system?
  - The present and future habitability of our own planet for humankind, and the potential environments beyond Earth where humankind might go in the future.

Roadmap Recommendations



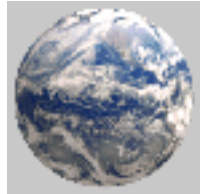
- Implementation of the roadmap requires a balanced program of small, medium and large-class(flagship) missions, a healthy R & A program, and a healthy Education & Public Outreach program
- Flagship class necessary in order to reach and explore difficult but scientifically high priority targets. These critically important targets could help establish the limits of habitability, not just in our solar system, but in any planetary system. Further, they potentially provide a true opportunity to identify organic molecules or even extant life, should it exist, in our own solar system.
- *Flagship mission targets are the crustal environment of Venus, the lower atmosphere and surface of Titan, the geophysics and astrobiology of Europa and Enceladus, the deep atmospheres of the giant planets, Kuiper Belt objects including Neptune's moon Triton, and the preservation of cryogenic samples of ices from a comet nucleus.*

Why a Flagship mission to Venus?

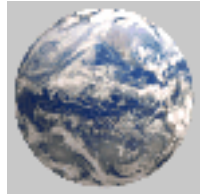


- Venus' surface- high priority target because it is so similar to the Earth in bulk properties and our closest neighbor, yet has such a different surface environment.
- Addresses all three habitability questions- emergence of life, architecture of planetary systems, and fate of Earth
- Isotopic evidence suggests that Venus lost large amounts of water earlier in its history. If an Earth-like environment persisted on Venus for an extended period of geologic time, geological and even biological signatures might have been left behind to be discovered today.
- While atmospheric studies of Venus and surface remote sensing observations can be done by low cost missions from orbit, access to the surface for durations long enough to do the required geochemical sampling over a potentially substantial area will require Flagship missions and intensive technology development.

Venus Surface Explorer (VSE)



- VSE Goal: determine how long ago an ocean disappeared from Venus, and how long Venus may have had to potentially nurture life.
  - Extensive surface measurements, including search for granitic and sedimentary rocks; analysis of the crust for metastable hydrated silicates; and measurements of the oxidation and mineralogical state of iron, and atmospheric analysis. Equipped with visual imaging and targeted set of geochemical sensors.
  - Air mobility platform with long traversing preferred over surface rover, which would have a limited range of hundreds of meters.
- Mobility provided advances in the understanding of geochemistry and hence past climate conditions on Mars; a similar understanding for Venus would be enabled by VSE, so that a more complete view of the interconnected cycles of chemistry, volcanism, and climate on Venus would be obtained.
- New start to end-of-mission- 6-7 years, including a surface stay time of days or weeks.
- New start in the second half of the second decade after Titan Explorer. To follow New Frontiers class Venus In-Situ Explorer (VISE), and allows additional time to develop high-temperature electronics and power for long lived surface missions.
- Crucial data for interpreting the spectral signatures and other data we will eventually obtain from terrestrial planets around other stars.



Next Steps

- Specific scientific goals and measurement objectives to be developed by VEXAG will be used to refine objectives of VSE
- VSE mission studies to refine cost estimates
- Development of balanced program which includes flagship missions