Small Bodies Assessment Group

Report to Planetary Science Subcommittee

October 10, 2012
Recent Activities

- Potential impacts to small bodies science of the President’s FY13 budget, with a review of House and Senate budgets.
- The health of the Discovery program and the upcoming selection (now made). New Frontiers program status.
- Report from the Roadmap Action Team, identifying strategic goals for small bodies exploration and sample requirement flow-downs.
- Lindley Johnson presented status and plans for NEOO.
Recent Activities

• Report on the Precursor Science Analysis Group (SBAG contributed to Phobos/Deimos requirements), feeding into the Mars Planning Group chaired by Figueroa.

• Report from the SBAG NEO/P/D Strategic Knowledge Gap Special Action Team (Rivkin) and the plan for integrating SKGs across destinations (Wargo).

• Status reports on Dawn, OSIRIS-Rex, Hayabusa samples, Rosetta, New Horizons, and NEOCam.

• Heard presentations from B612 and Planetary Resources, Inc. (which sparked considerable discussion)
Recent Activities

- Some innovative ideas about returning an entire (small) asteroid (Brophy, JPL), sending swarms of small s/c to asteroid/comet targets (Sheld, SETI), and a mass spectrometer (Weaver, APL).

- Report from a planetary balloon workshop (Kremik, NASA Glenn), focusing on potential benefits to studying asteroids and comets.

- New small bodies mission planning tools being made openly available (Dankanich, NASA Glenn).

- First of new regular reports to SBAG by the NASA Planetary Data System Small Bodies Node on holdings, new data, tools, and getting feedback on the extent to which they are supporting the needs of the small bodies community.
Findings from SBAG 7
The Discovery program has substantially collapsed as a source of planetary missions. In its first decade (1992–2001), ten missions were selected for launch. During its second decade (2002–2011), only one was selected. Implementation of the planetary decadal survey recommendation for a 24–month cadence of Discovery AOs is imperative. Merging the Mars Scout program with Discovery puts yet further pressure on this program. Restoring the Discovery program to two selections for launch per call is very important to the future of American solar system exploration. [The planned 2015 Discovery opportunity should be brought forward], as advocated by the decadal survey. [ ]
NASA may be allocating potentially significant resources (to be spent within the agency) to support the B612 private space-based telescope initiative. There are questions about the process by which this has come about and the transparency of that process. There are also questions about the conditions under which other groups pursuing a privately funded mission can expect similar support from the agency. Further information is needed to assess NASA's action and its implications.

NOTE: The SAA with B612 is now available and was discussed by the SBAG Steering Committee by telecon 9/27/12. Serious concerns remain and a SAT will be established to assess policy implications and report back to NASA.
SBAG reaffirms the high scientific potential of sample return missions, including missions currently selected and in the planning stages (OSIRIS–REx, Hayabusa–2, etc.). These missions also better inform our understanding of small body characteristics that are relevant for future human exploration. We reiterate the conclusions of the decadal survey that the continuing capability to conduct sample return missions is a desired outcome of maintaining a balanced portfolio of mission classes.
SBAG endorses the recommendations in the Precursor Strategy Analysis Group (PSAG) report relevant to Phobos and Deimos. This includes the importance of Phobos and Deimos as targets for human exploration. The PSAG report recognizes the potential strategic value of in situ resource utilization at Phobos and/or Deimos, which could significantly enhance human missions to the Martian system. The report concludes that a robotic precursor mission is required to conduct a combination of remote observations and in situ investigations at one or both moons prior to human arrival, in order to address strategic knowledge gaps in support of both science and human exploration endeavors.
SBAG is concerned that SKGs (strategic knowledge gaps relevant to human exploration) are to be ultimately prioritized by only engineers and technologists. After review by engineers and technologists, prioritization is best informed by including scientists in the discussion.
NASA Planetary Science Division investments in missions and research programs should be competed on the basis of science alone. Filling strategic knowledge gaps relevant to human exploration (SKGs) is a reasonable basis for additional investments by HEOMD to these programs, but should not undermine their science focus. [ ]
Other Recent Activities
1. List of required knowledge / data sets / technology, traced to human exploration needs.
2. Gaps in that knowledge / data sets / technology relative to our current understanding and capabilities.
3. A timeline of when the missing knowledge / data sets must be acquired or technology developed in order to make architecture-specific decisions or in order to make subsequent measurement decisions. In the context of this timeline, the group should consider interdependencies among the acquisition of knowledge, data sets and development of technology.
4. Provide a list of existing and potential missions, experiments, modeling activities, technology, or any other activity that would fill the knowledge gaps.

5. If additional measurements are required to fill knowledge gaps, identify the fidelity of the measurements needed, and if relevant, provide examples of existing instruments capable of making the measurements. The group should identify any ISS role in filling the gaps identified.

Charter:
“Of particular note is use of In Situ Resource Utilization (ISRU).”
Status: Report nearing completion.

Next: Integration across targets. Approach TBD, in consultation with MEPAG, LEAG, SBAG.
Draft CAN for NASA Research Institute for Science and Exploration

- Generally pleased about inclusion of small bodies
- Pleased about ~ 50-50 contribution by HEOMD
- However, per Finding 6, a listing of relevant SKGs should be included in the CAN to give guidance to proposers and allow HEOMD to better identify that work addressing its needs.
- Question: Is the Institute model cost effective? PSS was to be given budget breakdowns of NAI and NLSI. Large collaborative projects not as unusual or technologically challenging as they were 20 years ago.
NRO Optical Telescope Transfer to NASA – What to Do?

• Currently discussions within SMD center around advancing Astrophysics decadal goals.
• A Hubble-class facility could be of great value to the study of numerous, diverse, variable, small body populations in the solar system over large periods of time. (other solar system bodies too, of course…)
• Marc Allen (HQ) is organizing a workshop on eventual utilization of the transferred assets, which would include consideration of planetary and heliophysics.
• It would be advantageous for the different relevant AGs to contemplate a dedicated planetary telescope.
Science Nuggets
Comets Not from Kuiper Belt

- Stimulated by abundant CO$_2$ seen from Deep Impact spacecraft and Japanese AKARI satellite
- Relative abundances H$_2$O/CO$_2$/CO show Jupiter family (JFCs) and long period comets (LPCs) formed in largely overlapping region, probably 5-15 AU
- JFCs on average formed CLOSER to sun than LPCs
- Consistent with dynamical models
  - Migrating planets scatter to OC & SD
  - SD feeds JFCs
- Consistent with chemistry
  - D/H ratios in comets
  - No CO$_2$ gas in outer protoplanetary disks
  - Snow lines in Sun's protoplanetary disk models

Asteroid Vesta, target of NASA’s Dawn mission, is a heavily battered 500 km diameter terrestrial proto-planet. To better understand this asteroid and its evolution (and by extension the Earth, Moon, Mars and other planets) we simulate the formation of its two major basins, one after the other, starting with a sphere. **Top right** is the final shape of our model, looking a lot like the real asteroid, colored to show the depth of the excavated material (red is deepest). **Bottom right** is a comparison of our model with the Dawn mission topography for Vesta.

This research connects the collisions to the Dawn mission data, and to the meteorites on Earth that derive from Vesta.
Troughs on Asteroid Vesta are Evidence of Tectonics
Debra Buczkowski (APL), et al.

- Dawn spacecraft imagery shows large-scale linear troughs on the asteroid’s surface
- Topography and Morphology of the troughs indicate how they formed [Buczkowski et al., 2012]
- Orientation around Rheasilvia and Veneneia basins implies trough formation is related to the impact events
  - Other asteroids (eg. Eros, Ida, Lutetia) display fractures or grooves in a similar orientation around impact craters
  - But the size and morphology of Vesta’s troughs are consistent with fault-bounded graben
- First-order models demonstrate that Vesta’s differentiated interior could affect the impact-related stresses
  - Impedance mismatch due to core, mantle and crustal density differences concentrates the impact stresses
  - Allows for faulting instead of just simple fracturing
Hydrogen Found on Vesta by Dawn’s Gamma-Ray and Neutron Detector (GRaND)
Tom Prettyman (PSI), et al. – Science Magazine, 9/20/12

- Upper meter of Vesta sensed.
- H correlates with the distribution of lower albedo regions of the surface.
- Concentration consistent with carbonaceous chondrite inclusions found in some Howardite meteorites.
- Detected H most likely arises from the impact and mixing of dark, hydrogen-bearing carbonaceous asteroids with Vesta's native, bright basaltic crust.

Credit: NASA/JPL-Caltech/UCLA/PSI/MPS/DLR/IDA