

# Perspective on Contamination from the Small Bodies Assessment Group (SBAG)

SBAG seeks broad planetary science community input on small bodies and missions to small bodies.

**Stefanie Milam (NASA/GSFC)**, Julie Castillo-Rogez (NASA/JPL), Jason Dworkin (NASA/GSFC), Bonnie Buratti (NASA/JPL), Paul Abell (NASA/JSC), Henry Hsieh (PSI), Jennifer Scully (NASA/JPL), Maitrayee Bose (ASU), and the SBAG Steering Committee

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### Preliminary disclaimers

- This presentation is based solely on the input of:
  - SBAG steering committee members
  - Select community members involved in current missions or concepts
  - White papers submitted to the Planetary Decadal survey (publicly available)
- SBAG can propose to establish a study team (SIT) to provide a more community-based recommendation on this subject.
  - Staged input
    - 1. Initial study from survey data and input from funded missions and studies
    - 2. Post-flyby (Lucy) and Planetary Defense (DART) report
    - 3. Post-sample return analysis (Hayabusa2, OSIRIS-REx)

Suggest high level definitions, laws, and legislation made readily available to the community.

### Current Classification

Mission Type	Types of Planetary Bodies	Types of Bodies	Category
Flyby, Orbiter, Lander	PP reqs not obligated as there is no origin-of- life interest.	Ur m Vesta astorena	<u> </u>
Flyby, Orbiter, Lander	Bodies where there is an origin-of-life interest and rare chance that contam. carried by a spacecraft could jeopardize future missions.	Ve NEAScout <b>ts;</b> As target, Pluto, Se Charon, Triton	
Flyby, Orbiter	Bodies where there is an origin-of-life interest and there is a significant chance that contam. carried by a spacecraft could jeopardize future missions. PP documentation and implementation required.	Mars; Europa; Enceladus	111
Lander, Probe	Bodies where there is an origin-of-life interest and there is a significant chance that contam. carried by a spacecraft could jeopardize future missions. PP documentation and implementation required. Category IV missions for Mars are subdivided into IVa, IVb, and IVc.		IV

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## Scientific Knowledge SHOULD drive PP Requirements for Future Missions

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- Future surveys, fly-by missions, sample return, and Planetary Defense rendezvous will enhance the fundamental understanding of not only a class of object, but also help distinguish special or unique targets.
- For example, the Dawn mission to Ceres reveled numerous geologic/surface features that were not evident from remote sensing.
  - Key target for Astrobiology
  - Priority for lander



## Scary Cat's: Cat I vs Cat II

- Cat II entails extra activities, I&T facilities, documentation
  > \$, time
- Major players likely have planetary protection officers/facilities in place to help maintain requirements.
- Likely a bigger concern for non-NASA affiliated entities (e.g. Universities and other space
   companies) due to lack of expertise, proper test/integration facilities, and likely funded via lower cost programs.



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### High Priority Targets CLASSIFICATION: CAT II

### SBAG mission priorities (Goals & Questionnaire)

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Diverse objects; especially those not represented in the meteorite collection

### **New Frontiers**:

Discovery:

- Comet surface sample return (in Goals Document and first priority on SBAG questionnaire)
- KBO tour (in Goals Document)
- Ceres Lander (not in Goals Document, but prioritized since the document was published).
- Main Belt Tour (mentioned in SBAG questionnaire)
- Trojan tour (in Goals Document but not as compelling because of Lucy)

Flagship: 

- Cryogenic comet sample return (#1 in the SBAG questionnaire and mentioned in Goals Document)
- Pluto orbiter plus KBO tour (not mentioned in Goals Document)
- SBAG strongly supports the investigation of small bodies (Mars moons, outer irregular moons of the gas and ice giants; Centaur flyby enroute) as an integral part of a Flagship mission

https://www.lpi.usra.edu/sbag/goals/ https://www.lpi.usra.edu/decadal/sbag/

### EXAMPLES OF OUTSTANDING TARGETS

- Few or unique in nature
- Missions to carbonaceous asteroids are currently Cat II
- Missions to Pluto, Charon, Triton currently Cat II\*
- Ceres covered under "non-Cat I" asteroids; future; to be reconsidered for future lander/sample return missions

Recent geological activity, organics, candidate OW

CERES

### (2) PALLAS Second largest C-type asteroid Potential parent body of CM chondrites

ICY ASTEROIDS Different sizes → different evolution Organics present

(10) Hygiea

(2) Pallas

### INTERSTELLAR OBJECTS

1I/'Oumuamua

Small sample/statistics Organics MAY be present

PLUTO (and Charon) Recent geological activity, organics, candidate OW OTHER DWARF PLANETS, TRITON



(24) Themis

### Recommended Classification for Other Small Bodies CLASSIFICATION: CATIVS II

### Identifiable Population:

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refers to a subset of solar system small bodies defined by ranges of measurable known parameters, such as (a) orbital elements, (b) spectroscopic classification, (c) activity, (d) composition, and/or (e) size. Objects yet to be discovered, whose properties fall into the defining ranges, are to be considered members of the corresponding identifiable population.

### **Recommended Science Scope Classification:**

	Liquid interior	Spec. Class. (e.g. Organics)	Ocean World tracer (e.g. plumes)	Atmosphere	Uniqueness
Catl					
Catll		Υ		Υ	Υ
CatIII	Y		Y		

Cat II and I applies to flyby, orbiter, lander. Cat III applies to orbiters/flybys only.

Avoiding prioritization or generalization with population of small bodies and consider the science priority that would drive the category.

### Other Considerations:

Revisiting from flyb

Special c previous, scientific integrity contamin

> Habital
>  Size – c encour
>  Activity

\* Hierarchal







### Exemptions for Planetary Defense



Image credit: Continental Dynamics Workshop/NSF

PHAs or NEAs identified as a potential threat, should no longer be considered for classification and dealt with in a manner appropriate from a planetary defense perspective.

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- Known objects that are not considered a likely threat should follow previous recommendations and likely fall in Cat I.
- Future characterization and mitigation demonstration missions for planetary defense may go to a variety of objects (i.e., organic-rich asteroids, active asteroids, possibly comets, etc.) and may fall in Cat II.

### Sample Preservation

- Consider maintaining some predetermined percentage of population for a given type/class of object pristine for future studies (e.g. 50% set for NASA curation).
- A limited number of objects in categories with unique characteristics can be studied in detail and full consideration given to classification. Need community input.



# Final Thoughts

- ► Hierarchalsystem to consider:
  - Planetary Defense NONE
  - ► Key objects of interest (unique, mission specific) Cat II or III
  - Populations (hydrocarbon lakes, organics, evidence of ocean worlds, etc.) Cat II or III
  - Future missions (re-visiting) Cat II
  - Sample Statistics (number of objects identified/characterized) Cat I
- Cat III is only for orbiter/flyby and does not cover interest in landing on some of the candidates Ocean Worlds (Ceres and Triton in particular). The current PP framework is not adequate for such missions.
- Further study needed with broader community input.