

ExMAG Document #: ExMAG 005

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Topic: OSIRIS-Rex Cold Curation Questions

Background

JSC Astromaterials Curation has requested that ExMAG provide input into the question of whether some of the Bennu samples to be returned by the OSIRIS-REx mission should be curated under cold conditions to avoid loss of volatile species. The current plan, based on the experience of the Stardust mission, is to store a portion of the Bennu sample in a hermetically sealed container at room temperature to protect against volatile loss. However, in response to recent work on cold-stored Apollo-era lunar samples indicating that H and He can be lost over time at room temperature, some community members have communicated to Curation an interest that some of the OSIRIS-REx returned asteroid samples be similarly curated under cold conditions.

The ExMAG Asteroids subcommittee was asked to consider this issue and respond to five specific questions.

Analysis

The ExMAG Asteroids subcommittee met virtually on March 2, 2023 to discuss this issue. We considered both the background provided by Curation as well as additional experience of committee members. The overwhelming opinion of the committee is that NASA should indeed curate some of the Bennu samples at cold (commercial freezer) temperatures. We noted that (as cited in the request) the recent work of Burgess et al. (2022) showed that samples stored at cold temperatures for ~50 years retained solar-wind-implanted H and He whereas samples stored at room temperature had lost them. Since understanding volatile contents in the Bennu samples is of high scientific interest, it is important to ensure their retention in the samples over long time scales. We also noted that an analogous comparison of organic molecules between cold-curated and room-temperature Apollo ANGSA samples did not find strong differences (Elsila et al., 2023). However, given the vastly higher organics contents expected for the Bennu samples, based on likely carbonaceous chondrite analogues, we believe that it would be “better to be safe than sorry” and store some samples cold. At the very least, the comparison down the line of cold and room-temperature samples is likely to provide important information to inform future sample-return efforts. Finally, we noted that even at the lowest end of the estimate (150 gm returned Bennu sample), following our recommendation of cold-curating 2.5 wt% of the sample would correspond to a minimum of 3.75 gm, or ~70% of the total amount of Ryugu regolith returned by the Hayabusa2 mission. Given the large amount of scientific results already reported based on a tiny fraction of the Ryugu samples, we do not think a substantially larger sample would need to be cold curated.

Recommendations

1) Should part of the OSIRIS-REx returned asteroid bulk sample be curated under cold conditions?

Response: Yes

2) How much of the OSIRIS-REx returned asteroid sample should be curated under cold conditions? [% of bulk sample with defined maximum and/or minimum mass]

Response: We recommend that 2.5 %, up to 7.5 grams (i.e., half of the current plan for a hermetically sealed sample) be curated under cold conditions.

3) If OSIRIS-REx bulk sample should be curated under cold condition, what temperature range does ExMAG suggest? [cryogenic temperatures (10-25 K), LN2 temperatures (~75 K), commercially available freezer temperatures (~190 K), nominal cold curation temperatures (~250 K), and nominal curation temperatures (~300 K)]

Response: we recommend using commercially available freezers (~190K). Burgess et al. (2022) and Elsila et al. (2023) showed that storing lunar samples at temperatures of 250K had measurable impact on the retention of volatiles in nominally volatile- and organic-poor samples. Given the expected hydrated and organic rich nature of Bennu materials, colder temperatures (190K) are recommended for the OSIRIS-REx collection.

4) Should the cold curated sample replace some or all the currently planned hermetically sealed sample?

Response: Yes, we recommend that the cold curated replace 50% of the current plan for a hermetically sealed sample.

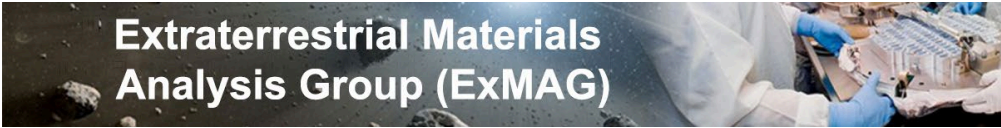
5) If yes to above, should the cold curated sample entirely replace the hermetically sealed sample? Or should the percentage of the hermetically sealed sample be decreased, if so, how much should the hermetically sealed sample be decreased? [% of bulk sample with defined maximum and/or minimum mass for both cold curated and hermetically sealed samples]

Response: as indicated by our recommendation to Question 4, we recommend that half the hermetically sealed sample should be replaced with a sample to be kept cold. We suggest that it is important to both, again largely for purposes of comparison to inform future efforts.

References

Burgess, K. D., Cymes, B. A., and Stroud, R. M (2022). Cold-Curation Enhanced Retention of Solar Wind Volatiles in Lunar Soil Silicates. LPI Contribution 2704, Abstract # 2037

Elsila, J. E., et al. (2023) Organic Compounds and Cyanide in the Apollo 17 ANGSA Samples. 54th LPSC, Abstract #1640



**Extraterrestrial Materials
Analysis Group (ExMAG)**

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