

Science Objective Summary and Science Weekly Debrief

Science Objective Summary

DOY 293–300: TAG week. OCAMS, TAGCAMS, and OTES will collect data to document the TAG attempt on DOY 294. To confirm sample acquisition, SamCam and TAGCAMS will perform post-TAG imaging on DOY 295. [The Sample Mass Measurement was nominally scheduled to take place on DOY 297 but was canceled owing to concerns about sample leakage from the TAGSAM head.]

Science Weekly Debrief

For slides and the WebEx recording on ODOCS, click [here](#) then follow the path: Folders \ Documents and Drawings \ OSIRIS-REx Bennu Proximity Operations \ Science Status \ Science Weekly \ 2020-10-22.

TAG + 1 day report-outs

Overview of TAG event [Dante Lauretta]

The TAGSAM head was in contact with the surface for 6.1 seconds, including 5.1 seconds of sample collection. The head contacted the surface with outstanding location accuracy at a speed of 10 cm/s and continued moving downward into the regolith at 4 cm/s during the period of contact. Preliminary accelerometer data indicate that the threshold for contact was crossed but that the spacecraft did not have to push very hard on the surface. Very little tilt of the head was observed even though it partially overlapped a 21-cm flat boulder, which may have been crushed. The head appears to have been flush with the surface. Substantial material was lofted by mechanical impact and by the firing of the gas bottle and subsequently the thrusters. Penetration depth was on the order of tens of centimeters for the 5.1 seconds during which the TAGSAM bottle was firing. Sample collection may have continued past this point as there is a lag between when the backaway thrusters fire and when the spacecraft begins its retreat. Surface excavation was observed, apparently associated with the firing of the thrusters.

The spacecraft experienced minimal tilt (a degree or less) and backed away at 40 cm/s; it is now in a safe Earth-point configuration. The Star Tracker was confused for a few hours but eventually locked with nine stars. NavCam 1 signal has been substantially degraded by dust loading (discussed further below). Other instruments may also have been affected. See the slides for details and upcoming activities.

TAGCAMS [Courtney Mario, Coralie Adam, Brent Bos, Carl Hergenrother]

NavCam 2 (a.k.a. NFTcam) backaway imaging presented by Courtney shows a cloud of debris obscuring surface landmarks. Surface disturbance appears to align with the TAG site and thruster locations. In particular, the backaway movie shows evidence of excavation, possibly craters or trenches forming under the thrusters. Excavation appears to continue after the thrusters cease firing, but exact times are yet to be added to the movie. As an interpretation aid, Brent mapped a

still image to indicate areas of clear surface view, high-density clouds of lofted particles, and strong shadows.

See Coralie's slides for NavCam 1 OpNav images showing green quivers for NFT features during the descent. NavCam 1 is showing a post-TAG signal degradation of 66% as a result of dust loading. However, we have sufficient signal for OpNav; no exposure changes are anticipated for a few weeks.

Carl observed millimeter-scale particles moving in shadows cast by rocks. In particular, trailed particles that do not seem to be emanating from the TAG site are captured in sufficient detail to show a lightcurve. Some trailed objects could still be seen with the spacecraft as of Thursday morning. Trailed particles will be added to the particle database.

OCAMS [Christian d'Aubigny, Bashar Rizk]

SamCam shows up to a 30% loss in signal, but some of that loss may have been due to the density of the dust cloud at the time of sampling (so actual loss may be less). We will have a sense of whether MapCam has lost signal when it begins to support OpNavs at the end of this week. See the OCAMS team's slides for GIFs and images. They interpret the SamCam video as showing that the contacted boulder is crushed by and ingested into the TAGSAM head.

IPWG [Dani DellaGiustina, Dathon Golish]

IPWG placed the location of the TAG site in the Recon C mosaic at about 30 cm from the NFT location. See the slides for location and coordinates (relative to pck v15; exercise caution with regard to different kernels and shape models when exchanging coordinates) and the current best OCAMS images and movies. A discrepancy of about 25 seconds with the current geometry was noted. We do not expect to have a full reconstruct until after the stow decision. Mark Fisher and team will run down discrepancies.

OTES [Vicky Hamilton]

Temperatures recorded by OTES were ~280K pre-TAG and ~262K post-TAG (OTES was powered off at TAG+60 seconds). Spectral shapes changed dramatically after TAG as well (see slides). OTES data are still being processed and interpretations of the observed changes are fluid at this point. Possible explanations include a thick, thin, or patchy layer of dust on OTES optics; OTES viewing Bennu through a dust cloud; finally resolving the Mg-OH feature; or some combination of the above. We will know more when OTES performs a space-looking functional test next week. Note that the lower-bound ground resolution of 5 cm reported in SPOCflight is not accurate because OTES does not have a focal point.

AltWG [Olivier Barnouin]

AltWG has 2-cm (or better) SPC DTMs associated with NFT features that they will try to get out to the team next week. AltWG is working on their own reconstruct, looking to build post-TAG topography. Bob Gaskell has registered images from the descent and some of the backaway.

Comparison with Hayabusa2 touchdown [Seiji Sugita]

Many particles were detected on the Hayabusa2's W1 camera filter following touchdown on Ryugu, whereas no dust has been observed on the SamCam filter following TAG. For both cameras, the point spread function remained the same even though overall transmission was reduced. OREx touched down onto dark, rough, reddish boulder on Bennu, whereas H2 touched down on a bright, smooth, bluish boulder on Ryugu; given the stratigraphy of each asteroid, both missions sampled relatively fresh material. Particle size appears to be a little finer at the OREx sampling site. About two times the amount of dust was lofted by OREx than by H2 during sample collection. See the slides or WebEx recording for visual comparisons of the sampling events.

Sampleability and science reconstruct [Kevin Walsh]

Preliminary rock counts on pre-TAG SamCam images identified at least 35 particles smaller than 2 cm in the TAG touchdown area; counting will continue. Rock tilt will essentially drop out of the sampleability assessment given the lack of tilt observed. The TAGSAM footprint encompassed part of a 21-cm dark rock but also smaller, bright, angular particles, indicating that the returned sample should contain diverse material.

Substantial material was mobilized and lofted, including dust before TAG began (see Carl's observations under TAGCAMS above). Rocks more than a TAGSAM head diameter away can be seen moving in the SamCam images; such movement is observed all around the TAGSAM head (not just in specific locations), indicating that the head was flush with the surface. The pogo spring was apparently not engaged in the first ~1 second of contact and possibly not at all. Therefore, maximum TAG force was probably low and surface penetration was probably correspondingly high—4 to 5 cm at the start of sample collection. The TAGSAM head was likely already packed with material when the gas bottle started to fire, which should guarantee capture of that material.

Upcoming meetings

The next meeting is moved up to Monday, 26 October, at 10 AM Tucson time, owing to a conflict with the DPS conference at the usual Thursday time.

Daily downlink slides for Day 293 (10/19/20). [Click to enlarge.](#)

All subsystems and instruments are nominal going into TAG tomorrow. OD291 is onboard and will be re-uplinked after TAG. Today's criticality-2 downlink is complete. All expected data from today and the past week came down nominally, except as noted below. The partitions are empty.

A repeating pattern was seen in TAGCAMS images downlinked DOY 292 (yesterday). The root cause is believed to be a radiation upset. The issue appears to have been resolved by the scheduled daily TAGCAMS resent. ISA 16640 was opened. About 5000 pixels are missing from a NavCam particle image downlinked today.

Looking ahead: TAG tomorrow 20 October (DOY 294)! NavCam 1, NFTCam, OCAMS, and OTES will collect OpNav and science data throughout the event, SamCam and TAGCAMS will collect images of the sampler head afterward, and the Sample Mass Measurement will be performed later in the week. The overflow partition will fill to 100% on DOY 294. For the TAG downlink (DOY 295), a downlink rate of 916 kbps will be manually commanded. Otherwise, the downlink rate will be 300 kbps this week. We will collect NavCam and MapCam OpNavs (various numbers per day) through the rest of the week.

There will be a Science Weekly this Thursday for an early post-TAG debrief. Sampling assessment meetings will take place daily from 21 to 27 October, ending with a sampling success review on 28 October for OKDP-3. Report-outs to the full team will take place at the Monday downlink tag-ups. Downlink tag-ups may not continue past nominal stow.

WOYs 46 and 47 are being built for an off-nominal TAG contingency involving spacecraft reboot.