

THE ROSETTA SCIENCE ARCHIVE: PREPARING FOR LEGACY SCIENCE

D. J. Heather¹, M. Taylor¹

¹ESA/ESTEC., 2200 AG Noordwijk, Netherlands

Introduction: 30 September 2016 marked the end of the Rosetta mission as the spacecraft came to rest on the surface of comet 67P/Churyumov-Gerasimenko. Although this marked an end to the spacecraft's active operations, intensive work has continued for several years, with the instrument teams updating their science data in response to recent scientific reviews and delivering them for ingestion into ESA's Planetary Science Archive (PSA) [1]. ESA has been working with a number of instrument teams to produce new and enhanced data products and to improve documentation in an effort to provide the best long-term archive possible for the Rosetta mission.

This presentation will outline the final status of the Rosetta archive, as well as highlighting some of the enhancement activities that have been completed in 2020 and the work undertaken to finalise and close out the Rosetta archive.

Status of the Rosetta data in the Planetary Science Archive: All science data from the Rosetta mission are hosted jointly by the Planetary Science Archive (PSA) at ESA (<http://psa.esa.int>) [1], and by NASA's PDS Small Bodies Node (SBN).

The long duration of the Rosetta mission, along with its diverse suite of instrumentation and the range of targets observed throughout its lifetime combine to make this an extremely challenging mission to archive [2]. A number of independent data reviews have taken place over the course of the mission in an attempt to track the evolution of the data pipelines from each instrument and ensure that the science data are documented and formatted in the best possible way to allow end-users to exploit them. The last of these took place in September 2020, and had a focus on closing out the enhanced archive deliveries from a number of instruments, as described in the following section. The outcome of the reviews were very positive and allowed for the final versions of these products to be prepared for inclusion in the Rosetta archive.

All teams have now completed both their nominal science data deliveries from the comet phase, and where appropriate, delivered final data from their enhanced archiving activities. All reviews were closed out and final products were delivered in 2020.

There have been nine large scale reviews in total on Rosetta, five of which have taken place after the clo-

sure of the nominal mission. In addition, a number of small individual reviews have been held to assess the final deliveries from some of the teams using their latest pipelines. In combination, these reviews have assessed the complete data holdings from Rosetta, and closely reviewed the updated outputs from the enhanced archiving activities, discussed in the following section. This series of reviews has ensured that the archive is now ready for the long-term when funding ended in December 2020.

Rosetta Enhanced Archiving Activities: The nominal archive deliveries from the Rosetta mission are of excellent quality, and will be of immense interest and use for many decades to come thanks to the efforts of all involved in their production, assessment, storage and dissemination. However, there is always more that can be done as calibrations and data reduction processes improve.

Once the resources from the operational mission came to an end, ESA established a number of joint activities with the Rosetta instrument teams to allow them to continue to work on enhancing their archive content. The updates planned were focused on key aspects of an instrument's calibration or the production of higher level data / information, and are therefore very specific to each instrument's needs. Several of these activities have already been running since 2017, and continued through to the end of Rosetta funding in December 2020. The activities ran for various lengths depending upon the activities to be undertaken. The full 'archive enhancement' process was completed with the closure of the final activities in late 2020.

This presentation will highlight just a few of the activities within the archive enhancement to give a flavour of the updates that have already been completed and those that are expected to be delivered in the coming months.

Almost all instrument teams have now provided a *Science User Guide* for their data, which have been highly appreciated by the scientists in the recent reviews. Most teams are also updating calibrations for their data, and some will be generating and delivering higher level processed data and derived products.

For example, the OSIRIS team have delivered data with improved calibrations, as well as straylight corrected, I/F corrected, and three-dimensional georeferenced products. These are all already available in the archive. OSIRIS has also started delivering their data additionally in FITS format, and now provide quick-look (browse) versions of their products in JPG format, to allow an end-user to more easily sift through the data and select the images they may be interested in. Internal straylight data and boresight corrected / full frame data were delivered in mid 2020, and have also now been added to the Rosetta archive. Outside of the officially supported activities, the OSIRIS team aim to make a final delivery of all of their data using the final and best pipeline available in April 2021. The aim is to have this large volume of data available in the final archive by summer 2021.

Similarly, the VIRTIS team are working to update both their spectral and geometrical calibrations, and will deliver mapping products to the final archive. This work has also been extended into early 2021, with the aim to close out the final versions by Easter.

The Rosetta Plasma Consortium (RPC) instrument suite completed several cross-calibrations that greatly improved the final data from each experiment, as well as a number of activities individual to each instrument (e.g. removal or flagging of spacecraft noise from the MAG instrument). An illumination map of the comet has also been produced by the RPC team to help with their cross-calibration work, which will be released early 2021 as well.

The MIDAS team has similarly completed some instrument cross-calibrations and has produced a dust particle catalog from the comet coma.

The GIADA team has produced and delivered higher level products in the form of dust environment maps, with omnidirectional plus time products..

The ALICE, RPC-IES and MIRO instruments on Rosetta are funded by NASA, and limited enhanced archiving activities were also undertaken for these. Data from these activities are all already released, but a few final small updates to a few products are expected early this year.

The COSIMA team recently delivered a ground-based catalog of spectra for comparison to help calibrate and understand their in-flight data. These are expected to be released early 2021.

A separate activity has also been established to produce and deliver data set(s) containing supporting ground-based observations of the comet. These data were taken simultaneously with Rosetta operations and could provide some important contextual information that will be of considerable value to the end user community. Final versions of these products were delivered in mid-2020. There is still some work needed to have these ready for a full ingestion, but the aim is to have these available in the archive early this year.

In addition to these activities, the Rosetta ESA archiving team has now produced and released calibrated data sets for the NAVCAM instrument, archived all of the radiation monitor data produced by the SREM instrument on Rosetta, and will be working with colleagues at PDS to include the latest shape models from the comet into the final Rosetta archive early this year.

Final PSA Updates: In 2020, the Rosetta ESA archiving team are also worked on providing a centralized solution to the problem of geometry on the comet for implementation within the final Rosetta data holdings. The latest version of the PSA includes a number of features to help exploit the Rosetta data with this in mind, including a 3D orbital view and a consistent set of queryable geometry data. These will be outlined in the presentation.

Summary: This presentation will outline the status of the final Rosetta science archive in ESA's PSA and in NASA's PDS. In addition, an overview of the few remaining activities will be provided. Thanks to the support of the instrument teams and the entire PSA team, the Rosetta archive will remain an immensely valuable resource for scientists in years to come, and the full scientific potential of the mission can be realized.

References: [1] Besse, S. et al., (2018) Planetary and Space Science v150, 131-140; [2] Barthelemy, M. et al., (2018) Planetary and Space Science v150, 91-103.