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1. **Nature:** R = Report, P = Prototype, D = Demonstrator, O = Other
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Executive Summary / Abstract:
A final update of the VA activities performed in the 4th year of the Europlanet 2024 Research Infrastructure is provided. Progress for each task is described as well as specific aspects, including impact of lighthouse activities of GMAP such as the GMAPWinter School, with insights on the last edition and outlook on the coming - final - one in early 2024. Links to documentation and relevant repositories are provided. Specific sustainability efforts and perspectives are included. Main areas of impact are also listed.

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List of acronyms and abbreviations

Table 1: Acronyms and abbreviations

Acronym	Description
ASI	Agenzia Spaziale Italiana (Italian Space Agency)
ASP	Ames Stereo Pipeline
DFG	Deutsche Forschungsgemeinschaft
DoA	Description Of Action
ISIS	Integrated Software for Imagers and Spectrometers
IRSPRA	Istituto Superiore per la Protezione e la Ricerca Ambientale
JRA	Joint Research Activity
MATISSE	Multi-purpose Advanced Tool for Instruments for the Solar System Exploration
NA	Networking Activity
MOST	Ministry Of Science and Technology
SSDC	Space Science Data Center
USGS	United States Geological Survey
VA	Virtual Access

Introduction

The GMAP VA activities are (see DoA, D8.1) include the following tasks:

- Task 8.1 - Coordination
- Task 8.2 - Community mapping projects
- Task 8.3 - 2D/3D Geological mapping
- Task 8.4 - Geological Mapping Integration
- Task 8.5 - Sustainability

The various tasks, individually and collectively, based on inputs and developments of the JRA (e.g. D9.2, Rossi et al., 2022; Rossi et al., 2023, D9.10) have been largely completed, and several deliverables have been produced[1] in the reporting period.

The third GMAP VA call coincided with the 3rd GMAP Winter School and resulted in several additional community mapping projects. For a review see D8.11 (Van der Bogert et al., 2023) and D8.12 (Carli et al., 2023).

Activities performed (per task) in the reporting period

The performed activities are described for each task. Plans and timeline for final activities of the various tasks are provided in the final section, as well as an evaluation of the impact achieved to date by the GMAP VA.

Task 8.1 - Coordination

Activities of coordination task 8.1 during the fourth year targeted the implementation of basic services supporting VA activities in terms of digital infrastructure, data and document management, as well as communication and collaboration systems.
The website, described in D8.2 (Massironi, et al., 2021) has been active; updates and fixes to the website continued following recommendations from the VA External Review Board (D1.8, Rough et al, 2022).
The code and documentation guidance based on the GMAP GitHub organisation[2] has been expanded and new releases of existing tools, such as the GMAP Jupyter Hub (see sections below), have been regularly published[3]. The same code is used for operational systems, i.e. the Hub instance[4], used both internally and by the community mapping projects, as needed. The wiki has been updated and expanded accordingly.

Task 8.2 - Community mapping projects

Task 8.2 has been further developed in the fourth year of the project, starting from the GMAP Winter School and VA calls and supported by monthly GMAP community calls, as well as informal non-periodic community interactions (mailing list, Discord server, etc.)

[1] https://wiki.europlanet-gmap.eu/bin/view/Main/Deliverables/

[2] https://github.com/europlanet-gmap

[3] e.g. https://github.com/europlanet-gmap/docker-jupyterhub

[4] https://jupyter.europlanet-gmap.eu/

Support to the community of mappers has been provided by GMAP members in the form of data processing and map-creation support (see D9.8. Rossi et a., 2023). Also, interaction with the US/USGS and LROC team communities took place in Year 4 of the VA, discussing further synergies for future activities and possible joint efforts.

The amount and variety of GMAP community mapping projects expanded steadily throughout the RI (see D8.11, Van der Bogert et al., 2023), at the moment of writing reaching 40 independent projects.

For a complete list of community mapping projects, please refer to the up –to date GMAP wiki page[5].

The 3rd Winter School allowed users to grow connections and foster community mapping projects. The report also includes some key figures of the 2nd and 3rd Winter School (see also Figures 1-3), as well as some preliminary figures from the 4th Winter School, scheduled at the very delivery time of the present document.

GMAP VA Call and Winter School

Similarly to years 2 and 3, the call has been established to remain open up to the original end date of the research infrastructure, to allow for eventual follow-ups of existing mapping projects and addition of new ones, expected to be limited.

The knowledge derived from the series of Winter Schools is comprehensive and meanwhile used as a reference source by several hundreds, if not thousands, of early career planetary scientists and students to self-learn, or for newcomers to the discipline to smooth their entry path.

The cumulative documentation produced by the first two Winter Schools is publicly available and its videos are used beyond the few hundred participants of the live events, for 2021 and 2022. See also D8.10 (Rossi et al., 2023).

[5] https://wiki.europlanet-gmap.eu/bin/view/Main/community%20mapping%20projects/

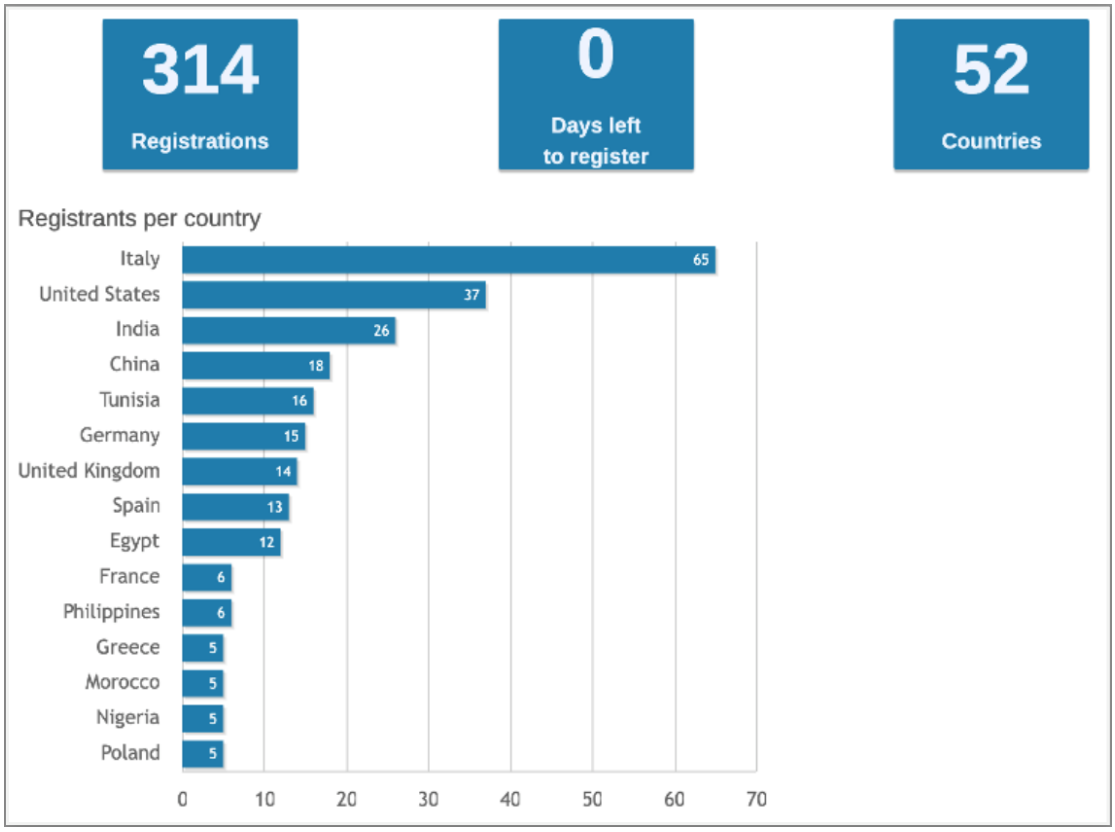

Figure 1: Breakdown of registered participants to 2022 GMAP Winter School (see also D8.10).

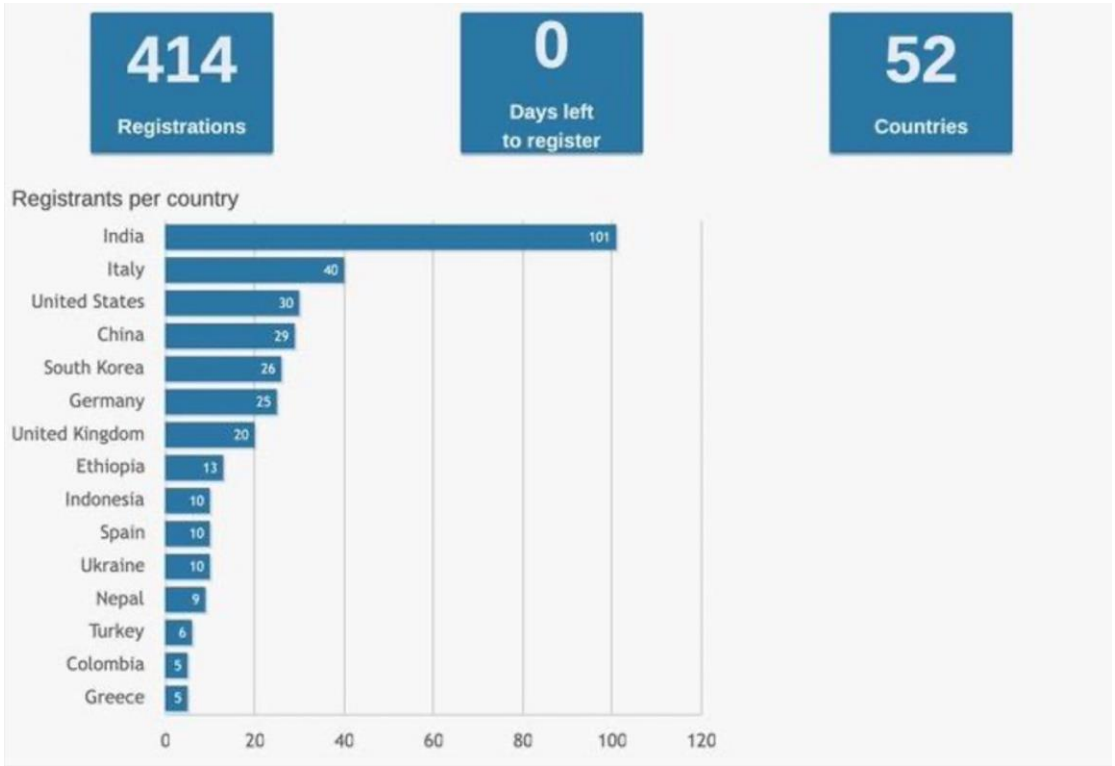

Figure 2: Breakdown of registered participants to 2023 GMAP Winter School

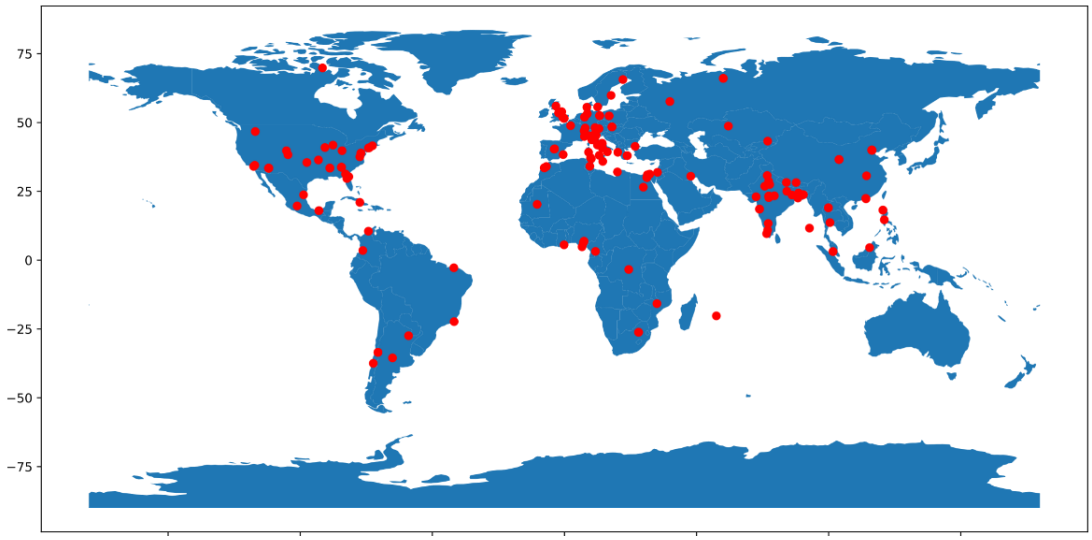

Figure 3: Geographic distribution of 2023 Winter School participants

The upcoming 3rd edition of the Winter School is planned for late January 2024 and will be entirely online and asynchronous. After two weeks of open registration the number of prospective participants topped 300 (Figure 4).

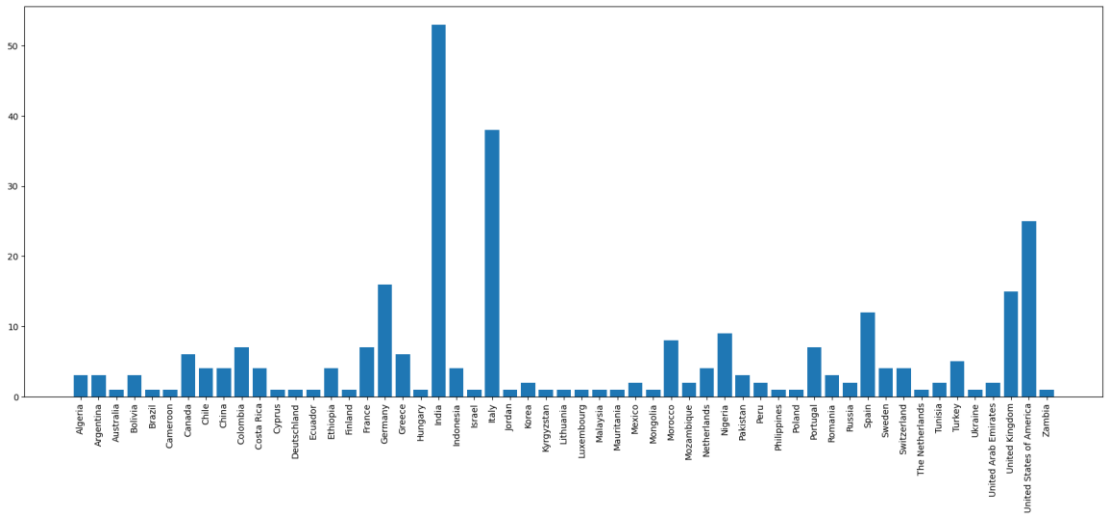

Figure 4: Preliminary, partial (mid-December 2023 figures) breakdown of registered participants to 2024 GMAP Winter School by country (alphabetic order). Please note this is based on the first 300 participants. Post-school figures will be published after the end of its asynchronous phase, and embedded in the next useful relevant reporting, latest in D8.14).

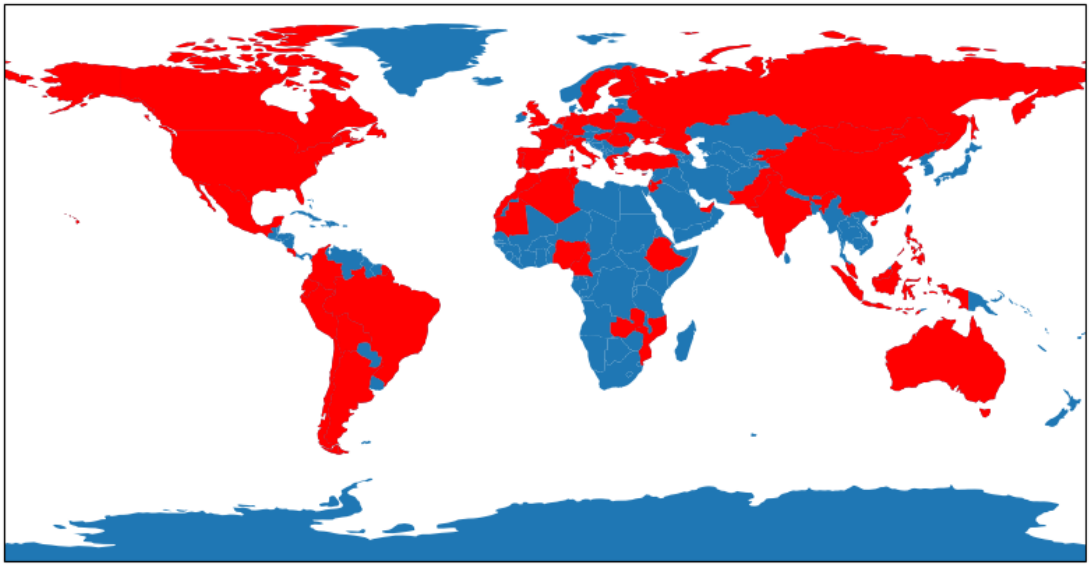

Figure 5: Preliminary, partial (mid-December 2023) figures showing geographic distribution of 2023 Winter School participants. Red areas denote represented countries (55).

The cumulative experience of online interaction for running the schools proved scalable (D8.4. Rossi et al., 2022). In particular, for the 2024 edition of the Winter School, the asynchronous interaction has been built in for participants coming from very distant time zones. Feedback from participants from each school has been processed and embedded in the structure and implementation of each following school. The 2024 edition has embedded all previous feedback.

Task 8.3 - 2D/3D Geological mapping

Activities of Task 8.3 continued addressing the creation of materials useful for both Winter School and interim workshops such as ERIM 2023[6]. Task 8.3 also contributed to several other community-driven projects that are instrumental to JRA activities. Teaching material has been created and adapted, and mapping tools needed for practical mapping activities and 3D model creation have been further developed and adapted. A range of desktop tools has meanwhile been developed and embedded in the mapping workflow. This can greatly ease the entry point for newcomers to planetary mapping, as well as removing financial barrier, enabling the use of fully open-source quality tools (see Impact section):

- Mappy[7][8] (Penasa et al., 2020)
- OpenCraterTool[9](Heyer, et al., 2023)
- Geologic Symbols[10] (integrated with Mappy)

[6] https://github.com/europlanet-gmap/erim-2023

[7] https://github.com/europlanet-gmap/mappy

[8] https://mappy.readthedocs.io

[9] https://github.com/europlanet-gmap/OpenCraterTool

[10] https://github.com/europlanet-gmap/geologic-symbols-qgis/

Task 8.4 - Geologic mapping integration

Within Task 8.4, additional web services were developed, extending the toolset available to the community and contributing to the legacy of GMAP:

- GMAP Data Portal (see D8.12, Carli et al, 2023)
- GMAP Jupyter Hub and related developments (see D8.12, Carli et al., 2023)

Based on mapping standards (See Nass et al., 2020; D9.1), preparation of partial products and associated metadata (Rossi et al., 2020; Nass et al., 2020; D9.1, and appendix therein) are made publicly accessible through the portal.

Please see D8.12 (Carli et al., 2023) for updates on the data portal content.

Task 8.5 - Sustainability

The activities in Year 4 of Task 8.4 covered a range of areas:

- Working on new bids and projects which can support planetary geological mapping activity during EPN2024 and beyond
- Increasing synergy and exchange with existing projects (such as the Horizon 2020 Project EXPLORE)
- Continuing exchange with the Chinese MOST project
- Setting up interactions with USGS for future cooperation. This is particularly relevant for future editions of the GMAP Winter School after the end of the RI, as well as additional technical and scientific exchanges.
- Consolidating the cooperation with the European and national space agencies, e.g. ASI. This is a continuing effort, specifically through the integration of GMAP and ASI SSDC MATISSE[11] (Camplone et al., 2021; Rognini et al., 2022).
- Following up with private companies interested in situ resource utilisation (SRK, see below) or 3D mapping (VRGS). VRGS is part of the 2024 Winter School schedule, with a full day of specific developments for the geologic mapping of minor bodies and interpretations in a full 3D environment.

The cooperation with USGS continues thanks to future common actions such as workshops, conferences as well as dedicated meetings.
The mapping projects and related products of the MOST project will be published via GMAP VA channels.
Heritage from JRA activities including the GMAP-developed Jupyter Hub for community use resulted in release of code on the relevant GitHub organisation[12].

Dissemination activities

GMAP has taken care of the whole organisation of the organised the third virtual Planetary Mapping Winter School that was held in early 2023, with 400+ (see Figure 2) registered participants from 34 countries. The 4th Winter School is starting at the end of January 2024, with 52 countries already represented one month before the registration deadline.
GMAP continues to foster its established presence on several online platforms for outreach:

[11] https://tools.ssdc.asi.it/matisse.jsp

[12] https://github.com/europlanet-gmap/docker-isis

- A Discord channel has been opened and maintained as a heritage to the first Planetary Mapping Winter School and to implement direct and asynchronous communication for the 2024 Winter School.
- Outreach channels on social platforms (e.g. Instagram[13], Twitter[14], Linkedin[15]) are used for the Winter School and will be maintained as a heritage to foster future didactic activities and workshops

Impact of GMAP VA

Four years after the beginning of the Europlanet 2024 Research Infrastructure and the first appearance of GMAP as a Europlanet 2024 activity, the impact is multi-fold. GMAP fosters geological mapping activities in an area where earlier attempts did not match community size, data, and tool availability. The first part of the 2020s saw several elements co-occurring:

- A growing planetary geologic mapping community in Europe, supported and linked through Europlanet 2024 RI, the Europlanet Society and the Europlanet Science Congress (EPSC)
- A growing number of datasets available
- A growing number of open-source tools available, including several developed within GMAP

This allowed for a larger impact of the activity than what would have been possible a decade or two earlier.

Scientific and methodological impact

- Development of tools aiding science linked to mapping (e.g. Heyer et al., 2023)

Technological impact

- Engagement with SMEs committed to terrestrial mapping

Impact on the Europlanet community

- The Europlanet community, including those engaged with NA workshops, were exposed to GMAP and discovered the activities, knowledge base, and tools thanks to other Europlanet activities, and would have not without. This includes Winter School participants coming from other Europlanet workshops, and vice versa.

Impact on standardisation

- Adoption and dissemination of developments in the geospatial realm (e.g. Hare and Malapert, 2021), within the mapping workflow.

Impact on the broader public

- The Winter School has been, despite its target in geoscience graduate students, very accessible for a wide range of backgrounds and seniorities. Throughout the series of schools, individuals ranging from high school students to retired individuals have learned the basics of planetary geological mapping.

[13] https://www.instagram.com/planetarymapping/

[14] https://twitter.com/PlanetaryGeoMap

[15] https://www.linkedin.com/company/planetary-mapping/

Cross-boundary impact

- Global reach of GMAP and its training activities beyond the EU. The Winter School is reaching a global audience. The open-source approach is suited for countries and institutions of any financial means.

Additional specific aspects will be described in relevant future RI-wide impact-related documents.

Relevant deliverables in the reporting period

- D8.10 GMAP VA 3rd year report (31 January 2023)
- D8.11 GMAP Community mapping report 2 (30 June 2023)
- D8.12 GMAP Geologic mapping integration report and published data (31 October 2023)

Deliverables are available on the GMAP wiki[16] as well as on the Europlanet Society RI relevant page[17].

Post-RI outlook

The GMAP VA comes to a formal end in July 2024. The efforts so far, and the engagement of several partners in continuing and expanding certain activities (see Task 8.5) aim at continuing sustaining key activities such as the Winter School in the time frame 2025+, as well as leveraging on the institutional infrastructure of other VA Activities, such as VESPA, for synergistic use of GMAP-developed tools such as its Jupyter Hub. Moreover, the final months of the VA will be used to expand and deepen the engagement with national space agencies, such as ASI.

Finally, the GMAP community built through the years will be kept within the reach of the Europlanet Society. This does not include only community mapping projects, but also Winter School alumni, several of which are already engaged and networked with various NA activities.

References

Brandt, C. H., Rossi, A. P., Penasa, L., Pozzobon, R., Luzzi, E., Wright, J., Carli, C., and Massironi, M.: PLANMAP data packaging: lessons learned towards FAIR planetary geologic maps, EGU General Assembly 2020, Online, 4–8 May 2020, EGU2020-18839, https://doi.org/10.5194/egusphere-egu2020-18839, 2020

[16] https://wiki.europlanet-gmap.eu/bin/view/Main/Deliverables/

[17] https://www.europlanet-society.org/europlanet-2024-ri/europlanet-2024-ri-deliverables/

Camplone, V., Zinzi, A., Massironi, M., Rossi, A. P. (2021) Geological Maps in MATISSE tool, European Planetary Science Congress 2021, EPSC2021-489.

Carli, C., Rossi, A.P., Brandt, C., et al. (2023) D8.12 Geologic mapping integration report and published data (second iteration), Europlanet H2020 RI deliverable, available online at https://wiki.europlanet-gmap.eu/bin/view/Main/Deliverables/

Heyer, T., Iqbal, W., Oetting, A., Hiesinger, H., van der Bogert, C. H., & Schmedemann, N. (2023). A comparative analysis of global lunar crater catalogues using OpenCraterTool–An open source tool to determine and compare crater size-frequency measurements. Planetary and Space Science, 231, 105687.

Luzzi, E., Rossi, A. P., Carli, C., Altieri, F. (2020) Tectono-magmatic, sedimentary and hydrothermal history of Arsinoes and Pyrrhae Chaos, Mars, JGR-Planets, DOI: 10.1029/2019JE006341.

Hare, T. M., & Malapert, J. C. (2021). Standards Proposal for 2021 to Support Planetary Coordinate Reference Systems for Open Geospatial Web Services. LPI Contributions, 2549, 7012 - http://voparis-vespa-crs.obspm.fr:8080/web/

- http://www.opengis.net/def/crs/IAU/2015

Nass et al., (2020) D9.1 GMAP Standard Definition Document, Europlanet H2020 RI deliverable, available online at:

https://wiki.europlanet-gmap.eu/bin/view/Main/Deliverables/=

Nodjoumi, G., Pozzobon, R., Sauro, F., Rossi, A. P. (2023) DeepLandforms: A Deep Learning Computer Vision toolset applied to a prime use case for mapping planetary skylights. Earth and Space Science, DOI: 10.1029/2022EA002278.

Penasa, L., Frigeri, A., Pozzobon, R., Brandt, C. H., De Toffoli, B., Naß, A., Rossi, A. P., and Massironi, M.: Constructing and deconstructing geological maps: a QGIS plugin for creating topologically consistent geological cartography, Europlanet Science Congress 2020, online, 21 September–9 Oct 2020, EPSC2020-1057, https://doi.org/10.5194/epsc2020-1057, 2020

Raugh, A. C., Arviset, C., Jackman, C. M, Kerner, H., Lapenta, G., Marmo, C., Melis, M. T., Williams, D. A. (2020) VA 1st year External Board Review, Europlanet Deliverable D1.5.

Rognini, E., Camplone, V., Zinzi, A., Mura, A., Milillo, A., Massironi, M., Rossi, A. P., Zucca, F., and Capria, M. T.: Mercury exploration with MATISSE tool, Europlanet Science Congress 2022, Granada, Spain, 18–23 Sep 2022, EPSC2022-658, https://doi.org/10.5194/epsc2022-658, 2022.

Raugh, A. C., Arviset, C., Jackman, C. M, Kerner, H., Lapenta, G., Marmo, C., Melis, M. T., Williams, D. A (2022) VA 2nd year External Board Review, Europlanet Deliverable D1.8.

Rossi, A. P., Penasa, L., Pozzobon, R., Massironi, M., Brandt, C., and the GMAP partners (2021) D9.2 JRA Report Year 1, Europlanet H2020 RI deliverable, available online at: https://wiki.europlanet-gmap.eu/bin/view/Main/Deliverables/

Rossi, A. P., Penasa, L., Pozzobon, R., Massironi, M., Brandt, C., and the GMAP partners (2022) D9.6 JRA Report Year 2, Europlanet H2020 RI deliverable, available online at: https://wiki.europlanet-gmap.eu/bin/view/Main/Deliverables/

Rossi et al. (2022) D8.5 Community mapping report 1, Europlanet H2020 RI deliverable, available online at: https://wiki.europlanet-gmap.eu/bin/view/Main/Deliverables/

Rossi, A.P., Pozzobon, R., Penasa, L. Massironi, M.., et al. (2022) D8.4, GMAP VA Report Year 2, Europlanet H2020 RI deliverable, available online at https://wiki.europlanet-gmap.eu/bin/view/Main/Deliverables/

Rossi, A.P., et al. (2022) D8.10, GMAP VA Report Year 3, Europlanet H2020 RI deliverable, available online at https://wiki.europlanet-gmap.eu/bin/view/Main/Deliverables/

Rossi, A.P., Pozzobon, R., Penasa, L. Massironi, M.., et al. (2023) D9.8 GMAP JRA Report Year 3, Europlanet H2020 RI deliverable, available online at https://wiki.europlanet-gmap.eu/bin/view/Main/Deliverables/

Van der Bogert, C. et al. (2023) D8.11 community mapping report 2, Europlanet H2020 RI deliverable, available online at: https://wiki.europlanet-gmap.eu/bin/view/Main/Deliverables/