EUROVOLC

**European Network of
Observatories and Research Infrastructure for Volcanology**

Deliverable Report

D6.2 Harmonizing volcano DP

Work Package:	*Networking volcano observations of sub-surface processes and initiating access to observations from the Krafla Volcano Laboratory*
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Work Package leader:	*Freysteinn Sigmundsson*
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Contents

Summary

Work within work package 6 in EUROVOLC was related to networking Data, Data Products, Services and Software (DDSS). The work complements the Implementation Phase of the European Plate Observing System project (EPOS-IP) and utilizes some of the services generated in EPOS-IP to facilitate and maintain long-term access to the data and data products. This report highlights efforts carried out in relation to subtask 6.1.2 in EUROVOLC: "Harmonising geophysical, volcanological and geochemical data, metadata and products that have not been implemented in EPOS-IP. It includes work on realizing metadata and steps taken towards implementation of access to collection of magmatic rocks by partners INGV and CSIC. UNIVLEEDS made available ground deformation results from selected areas around the globe, based on interferometric analysis of synthetic aperture radar images (InSAR), and DIAS and CVISA networked seismic data from Iceland and the Azores. Partner UCA created tool for automatic creation of outline of new lava flows using InSAR products. Work was carried on citizen science data tools by partner NERC, and collection of volcano observations at Greek volcanoes by partner HSGME. Partners IMO and UI carried out work to network data in relation to eruptions in Iceland, reported in deliverable report 6.3.

Introduction

This report describes work carried out in relation to Subtask 6.1.2 in EUROVOLC: "Harmonising geophysical, volcanological and geochemical data, metadata and products that have not been implemented in EPOS-IP". This subtask was devoted to harmonising, and implementation of access to selected geophysical, volcanological and geochemical data and products, where necessary by means of standardizing meta-data and data formats in accordance with EPOS TCS standards. Partners worked on selected numbers of *Data, Data Products, Services and Software* (DDSS), to be networked in EUROVOLC.

One of the most basic types of observable in volcanology is a sample of a magmatic rock. Yet, there has not been a common understanding how best to describe such samples in consistent and uniform manner. In EUROVOLC, a special emphasis was to resolve this issue.

Collection of magmatic rocks

Work, led by partners INGV and CSIC, was carried out to realize metadata and take steps towards implementation of access to collection of magmatic rocks. The description of a rock sample is performed following various steps described in a flowchart (Figure 1), which was decided on in the first half of EUROVOLC by a group of partners. For this DDSS, information is provided about: 1) the volcano or the volcanic area where the sample comes from; 2) the identification of the sample; 3) the field characteristics of the sample; 4) the characteristics of the eruption (is available for recent activity); 5) the setting of the sample which may be 5.1) a lava flow, 5.2) a pyroclast, or be a part of 5.3) a stratigraphic section, 5.4) a dredge, or 5.5) a borehole.
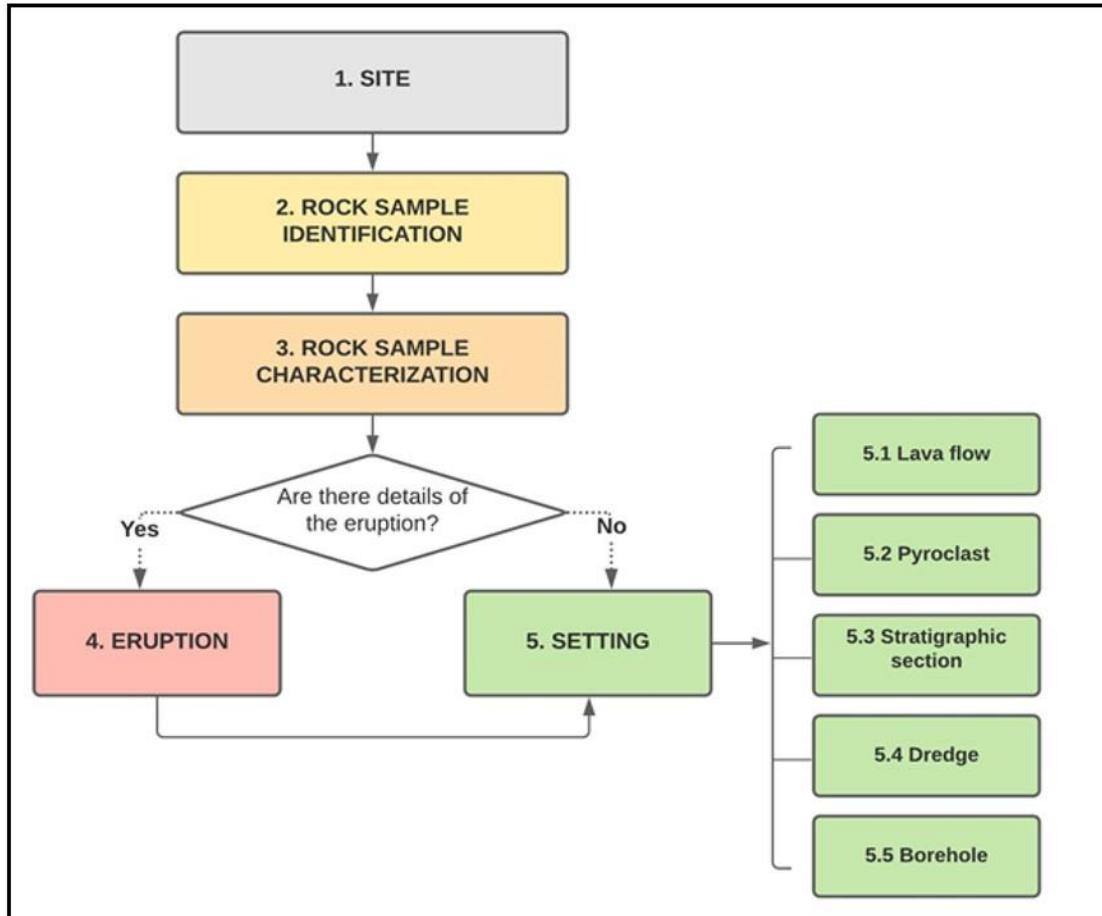
Figure 1. *Flow chart of the metadata associated with the "Collection of magmatic rocks (DDSS-026)".*

In relation to this flowchart, a decision was taken on the description of the metadata for collections of magmatic rocks" (DDSS-026). The metadata is listed in Tables 1 to 4 for all samples, and then Tables 5.1 to 5.5 dependent on the type of sample location. The flowchart and metadata tables were provided by INGV.

***Table 1.** Site*

FIELD	DESCRIPTION
Site_Region	Geographic region of the world where the site is located (e.g. Africa, Asia, Caribbean, Central America, Europe, N-America, Oceania, S-America)
Site_Country	Country where the site is located
Site_name	Name of the site. The volcano name according to GVP*
Site_ID	Number that uniquely identifies the site. For a volcano is the GVP volcano number
Site_LAT	Latitude of the site
Site_LON	Longitude of the site
Site area_LAT(N)	If the site is an area (box), this is the Latitude Nord of the box
Site area_LAT(S)	If the site is an area (box), this is the Latitude Sud of the box
Site area_LONG(E)	If the site is an area (box), this is the Longitude E of the box
Site area_LONG(W)	If the site is an area (box), this is the Longitude W of the box

*GVP Global Volcanism Program, Smithsonian Institution.
https://volcano.si.edu/search_volcano.cfm

***Table 2.** Rock sample identification*

FIELD	DESCRIPTION
Sample_id	Identification number of the sample
Sample_IGSN	Number that uniquely identifies the sample. It's assigned by SESAR**
Sample_label	Name of the sample
Sampling_date	Date of sampling (YYYY/MM/DD)
Sample_unit	Geological unit of the sample, according to scientific literature data
Sample_age	Age of the sample according to scientific literature data
Sample_LAT	Latitude of the sample
Sample_LON	Longitude of the sample
Sample_elevation	Elevation of the sample (m a.s.l.)
Sample _notes	A free text for any information useful to identify the rock sample
Sample_collection	Name of the collection the sample belongs to
Sample_shelf	Identifier of the shelf where the sample is archived in the lithoteque
Sample_box	Number of the box that contains the sample

**SESAR System for Earth SAmple Registation,
http://www.geosamples.org/

Table 3. *Rock sample characterization*

FIELD	DESCRIPTION
Sample_lithology	Description of the physical characteristics of the sample visible in hand or with low magnification microscopy. The description must use terms of a fixed Vocabulary ***
Sample_collector	Last and fist name of the sample's collector
Sampling _instrument	Description of the instrument used to collect a rock sample (e.g. hammer, core barrel, dredge, other, etc.)
Sampling_method	Description of the sampling method (e.g. total mass, hand picking, other, etc)
Sample_weight	Weight of sample (g)
Sample_note	A free text for any information useful to describe the rock sample

***Vocabulary, see:
USGS Glossary of Igneous rocks
https://volcanoes.usgs.gov/vsc/glossary/igneous.html
Australian Research Data Common – Simple lithology vocabulary
https://vocabs.ardc.edu.au/repository/api/lda/ga/simple-lithology/v0-1/concept.html?_page=1&_view=basic&_metadata=all

Table 4. *Eruption*

FIELD	DESCRIPTION
Eruption_id	Identication number of the eruption
Eruption_name	Name of the eruption
Eruption_description	Description of the activity of the eruption (eg: effusive, spattering, Strombolian explosions, paroxysm, ash emission, other)
Eruption_time_start	Start date of eruption
Eruption_time_end	End date of eruption
Eruption_localization	Description of the eruption location useful to identify the eruptive vent/fissure producing the sample (e.g. name of the crater, altitude of a sector of eruptive fissure, other, etc.)
Eruption_LAT	Latitude of the eruption site (vent/eruptive fissure)
Eruption_LONG	Longitude of the eruption site (vent/eruptive fissure)
Eruption_elevation	Elevation of the main eruption site (vent/eruptive fissure) (m a.s.l.)
Eruption_notes	A free text for any information useful to describe the eruption

Table 5.1. *Setting_Lava flow*

FIELD	DESCRIPTION
Flow_location	General statement describing where the lava flow sample is located (e.g. vent/eruptive fissure, ephemeral vent, lava channel, lava front, levees, other...)
Flow_eruption date	Date of lava flow sample eruption (YYYY/MM/DD)
Flow_error_date	A free text for describing possible error of the eruption date
Flow_texture	Description of the texture of the lava flow
Flow_section	The portion of the lava flow which has been sampled (e.g. surface, intermediate, base, other)
Flow_status	Conditions of lava flow advancement during the sampling (e.g. ongoing, stopped, other, etc.)
Flow temperature	The measured temperature of lava flow in the sampling zone
Quenching_mode	The mode of sample cooling (e.g. air, water, snow, unknown, other)
Flow_notes	A free text for any information useful to describe the lava flow outcrop
Flow_photo	Photo/s of the lava flow

Table 5.2. *Setting_Pyroclast*

FIELD	DESCRIPTION
Pyro_location	General statement describing where the pyroclastic sample is located (e.g. vent/eruptive fissure, proximal area, distal area other...)
Pyro_eruption date	Date of pyroclastic sample eruption (YYYY/MM/DD)
Pyro_error_date	A free text for describing possible error of the eruption date
Pyro_sampling_start	Starting sampling time (hh:mm)
Pyro_sampling_end	Ending sampling time (hh:mm)
Pyro_size	Dimension of the pyroclastic fragments (e.g. bomb, lapilli, ash)
Pyro_texture	Description of the texture of the pyroclastic sample
Pyro_area lenght	Length (cm) of the sampled area of a pyroclastic deposit
Pyro_area width	Width (cm) of the sampled area of a pyroclastic deposit
Pyro_area thickness	Thickness (cm) of the sampled area of a pyroclastic deposit
Pyro_notes	A free text for any information useful to describe the lava pyroclastic outcrop
Pyro_photo	Photo/s of the pyroclastic deposit

Table 5.3. Setting_Stratigraphic section

FIELD	DESCRIPTION
Section_label	Name of the stratigraphic section
Section_layer	Position of the sampled layer along the section. It's expressed as the distance (cm) from the base of the layer to the baseline of the section
Section_sample position	Position of sample along the section. It's expressed as the distance (cm) from the sample to the baseline of the section
Section_Layer thickness	Thickness (cm) of the sampled layer
Section_contact_top	Type of contact of the sampled layer with the top (e.g. Conformity, Disconformity, Angular unconformity, Non-conformity, Intrusive, Fault/Tectonic)
Section_contact_bottom	Type of contact of the sampled layer with the bottom (e.g. Conformity, Disconformity, Angular unconformity, Non-conformity, Intrusive, Fault/Tectonic)
Section_Layer_continuity	Type of lateral continuity of the sampled layer (e.g. p)inch-out, intertonguing, lateral gradation, continuous at section scale
Section_Deposit_Colour	Description of the color of the sampled layer
Section_Deposit_Rock type	Overall description of the rock mass (e.g. coherent rock or loose/granular material)
Section_Deposit_Primary structure	Description of the internal primary structure of the sampled layer (e.g., plane-parallel-bedding, cross-bedding, lamination, massive)
Section_Deposit_Texture	Description of the arrangement of the grains (e.g., clast-supported, matrix-supported)
Section_Deposit_Grain size	Description of the grain size of the deposit (e.g., coarse, medium, fine) and its sorting (e.g. well-sorted, ..., poorly sorted)
Section_Deposit_Grading	Descriprion of the grain size variability of the sampled layer from the base to the top (e.g., normal, reverse, non-graded)
Section_type of deposit	Description of the type of deposit from which the sample come from (e.g. loose pyroclasts, lava flow, rhemorphic flow, spatter-like, ash rich, etc..)
Section_stratigraphic markers	Description of stratigraphic markers (e.g. soils undelying the eruption deposit, marker layer, dikes, large ballistic bombs)
Section_notes	A free text for any information useful to describe the stratigraphic section
Section_Photo	Photo/s of the stratigraphic section. It should show the sample position
Section_Drawing	Drawing of the stratigraphic section. It should show the sample position.

Table 5.4. Setting_Dredge

FIELD	DESCRIPTION
Dredge_cruise_name	Name of the cruise
Dredge_cruise_locality	Locality of the cruise
Dredge_ship_name	Name of the ship
Dredge_Leg_name	Name of the LEG
Dredge_scientist	Scientist in charge of the Leg
Dredge_cruise_depart	Depart site of the cruise
Dredge_cruise_start	Cruise starting date
Dredge_cruise_arrival	Arrival site of the cruise
Dredge_cruise_end	Cruise ending date
Dredge_name	Name of the dredge
Dredge_sampling_start	Starting sampling time of the dredge (hh:mm)
Dredge_sampling_end	Ending sampling time of the dredge (hh:mm)
Dredge_start_LAT	Starting latitude of the sampling site (A)
Dredge_start_LONG	Starting longitude of the sampling site (A)
Dredge_end_LAT	Ending latitude of the sampling site (A)
Dredge_end_LONG	Ending longitude of the sampling site (A)
Dredge_start_depth	Starting water depth of the dredge(m)
Dredge_end_depth	Ending water depth of the dredge (m)
Dredge_start_winch	Starting winch release (which is the unit of measure?)
Dredge_end_winch	Ending winch release (which is the unit of measure?)
Dredge_total weight	Weight of the total dredged samples (kg)
Dredge_lithology	Is the dredged heterolitologic? (y/ n)
Dredge_description	Description of the bulk dredge sample (e.g. including presence of sediments, clay coating ,incrustation, other, etc.)
Dredge_notes	A free text for any information usefull to describe the dredge
Dredge_photo	Photo/s of the dredge

Table 5.5. *Setting_Borehole*

Borehole_id	Name of the borehole
Borehole_loc_name	Locality of the borehole
Borehole_loc_description	DescrLocality of the borehole
Borehole_LAT	Latitude of the borehole
Borehole_LONG	Longitude of the borehole
Borehole_elevation	Elevation of the borehole (m a.s.l.)
Borehole_Geod_Datum	Geodetic datum of the coordinates
Borehole_project_ name	Drilling project name
Borehole_ company	Owner company name
Borehole_dril_contractor	Drilling company name
Borehole_dril_start	Date of drilling start (YYYY/MM/DD)
Borehole_dril_end	Date of drilling end (YYYY/MM/DD)
Borehole_dril_method	Drilling method e.g. diamond, air core, percussion, continuos or distruction drilling etc.
Borehole_start_depht	Elevation of the borehole head (m a.s.l.)
Borehole_endg_depht	Elevation of the borehole bottom (m a.s.l.)
Borehole_dril_thickness	Total thickness of the drilled sequence (m)
Borehole_recovery _%	The proportion of the drilled rock column recovered as core in core drilling (%)
Borehole_dril_log	Vertical log of the drilling operation
Borehole_strat_log	Vertical log of the drilled lithological sequence
Borehole_sampl_log	Vertical log of the sampling points
Borehole_downhole_logs	In-hole physico-chemical properties logs
Borehole_material_log	Tipology of materials recovered from depht (m) to depht (m) e.g.cores, cuttings
Borehole_storage_site	Institution responsible of the storage address
Borehole_Repository	Repository where the sample is archived
Borehole_repos_contact	Contact name and address of the responsible of repository
Borehole_Rights holder	Name of the rights holder
Borehole_tech_rep	Different technical reports e.g. drilling plan, drilling operations, stratigraphyc, geochemical, geophysical, final
Borehole_notes	A free text for any information usefull to describe the borehole
Borehole_photo	Photo/s of the borehole (e.g. drilling site, drilling operations, core boxes, samples)

Work was also carried by CSIC to create a database of magmatic rock samples and preparing an associated web application. This database lists those magmatic rock samples collected and studied by the GEO3BCN – CSIC /IGN (Geosciences Barcelona, Spanish Research Council / Instituto Geográfico Nacional) working group, compiling information regarding the sampling site, the rock type, the available analyses and descriptions, among many other fields.

A web user interface was developed that accesses the data base has been created. A user can query the database content using different parameters such as location, site name, volcano Name, etc. The web interface also includes a map showing the location of those rock samples currently included in the database. The query returns a table with the selected samples. This table can be downloaded as a .csv file. Additionally, by clicking at each of the listed samples, the user can see all information available and links to data repositories including chemical analyses, sample images, etc. Examples of use of the interface and the web application are shown in Figures 2-4.

The database contains general information regarding location, sampling site, and availability of geochemical, petrological, mineralogical and isotopical analyses and data for each of the included rock samples. For now, the database only contains rock samples from Deception Island volcano (Antarctica) but is being continuously updated and will include in the future samples from Canary Islands, Iceland and the Catalan Volcanic Zone.

Figure 2. *Screen-shot of the on-line database form with all fields that may be use for querying and filtering the database content. Once the different searching criteria have been selected, the user has to click "Search" button to obtain the resultant database records. The on-line form also includes an image of a map where it is indicated from which locations the rocks contained in the database are from.*

⬇ Export search results as CSV

Sample Label	Sample IGSN	Site Name	Sample Locality	Sample Notes	Sample Age	Average Composition	Thin Section	URL1
DIPV1	https://app.geosamples.org/sample/igsn/IED180001	Deception Island	Cross Hill (Telefon Ridge)	basic pumice (in situ) from Cross Hill	Holocene	Basalt-andesite	YES	
DIPV2	https://app.geosamples.org/sample/igsn/DIPV2	Deception Island	Cross Hill (Telefon Ridge)	metamorphic material? - basement? (in situ	not provided	Basalt-andesite	YES	
DIPV3-A	https://app.geosamples.org/sample/igsn/DIPV3-A	Deception Island	Cross Hill (Telefon Ridge)	On the cone plunge (tutti frutti material mix). different clastic types - Dilute pyroclastic density current or Dense Pyroclastic density current (PDC)	not provided	Basalt-andesite	YES	
DIPV3-B	https://app.geosamples.org/sample/igsn/DIPV3-B	Deception Island	Going up Cross Hill (Telefon Ridge)	On the cone plunge (tutti frutti material mix). different clastic types-Red Lithic	not provided	Basalt-andesite	YES	
DIPV3-C	https://app.geosamples.org/sample/igsn/DIPV3-C	Deception Island	Going up Cross Hill (Telefon Ridge)	On the cone plunge (tutti frutti material mix). different clastic types- Yellow tuff . possible Outer Coast Tuff Formation (OCTF)	not provided	Basalt-andesite	NO	
DIPV3-D	https://app.geosamples.org/sample/igsn/DIPV3-D	Deception Island	Going up Cross Hill (Telefon Ridge)	On the cone plunge (tutti frutti material mix). different clastic types-Scoriaceous material	not provided	Basalt-andesite	YES	
DIPV3-AA	https://app.geosamples.org/sample/igsn/DIPV3-AA	Deception Island	Going up Cross Hill (Telefon Ridge)	On the cone plunge (tutti frutti material mix). different clastic types- JUVENILE SCORIA	Holocene	Basalt-andesite	NO	
DIPV3-AB	https://app.geosamples.org/sample/igsn/DIPV3-AB	Deception Island	Going up Cross Hill (Telefon Ridge)	On the cone plunge (tutti frutti material mix). different clastic types-JUVENILE SCORIA	Holocene	Basalt-andesite	NO	

Figure 3. *Screen-shot of how the results of the database query are shown. Each row corresponds to one magmatic rock sample. Only the most relevant fields are shown at this stage of the database search. In order to obtain the complete records, the user needs to click on "Export search result as csv". To visualize the complete record of each of the samples, the user only needs to click on "Sample Label" and the system will show the corresponding full register (see Fig. 3) as an example.*

Figure 4. Example of a section of the full record of one of the included samples. An example of the complete record can be found at:
*http://gvb-csic.es/database_magmatic_rocks/file.php?id=1*

Products from interferometric analysis of synthetic aperture radar images (InSAR)

UNIVLEEDS has made accessible ground deformation results from selected areas around the globe, based on intereferometric analysis of synthetic aperture radar images (InSAR). InSAR is used to form interferograms that show estimated line-of-sight (LOS) change from ground to satellite. Interferograms and time series of interferograms from Sentinel-1 are formed, in regions of volcanic and tectonic interest.

Whole interferograms are available through the COMET-LiCS portal:

https://comet.nerc.ac.uk/comet-lics-portal/

The opening page of the COMET-LiCS portal is shown in Figure 5.
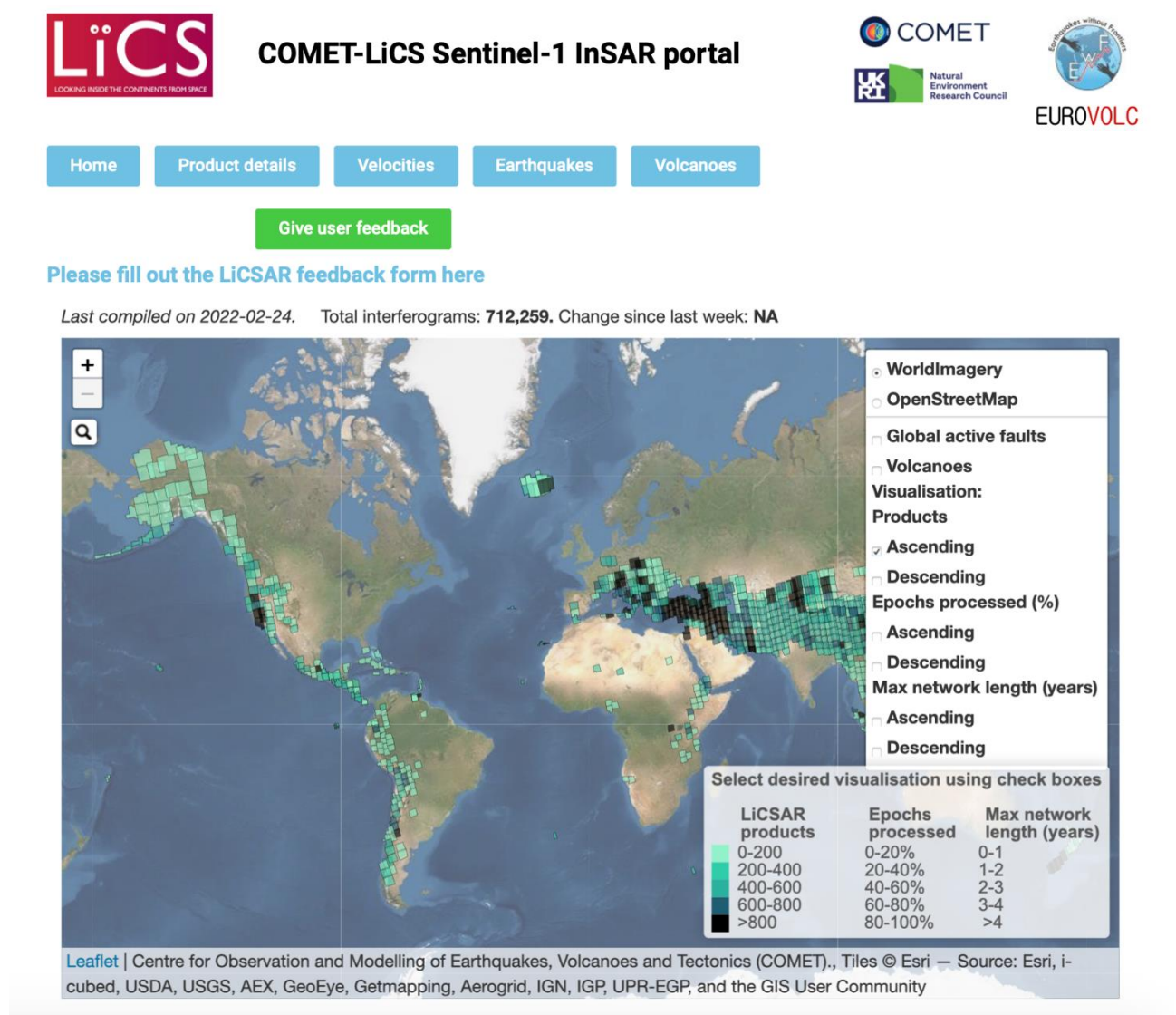
Figure 5. *The main webpage of the COMET-LiCS InSAR portal, that opens access to more than >700000 interferograms.*

The primary support for this portal has been by the UK Natural Environment Research Council through the Centre for the Observation and Modelling of Earthquakes, Volcanoes and Tectonics (COMET), the "Looking inside the Continents from Space" large grant, and the "Earthquakes without Frontiers" consortium. EUROVOLC has contributed as well. Advances during the EUROVOLC project include the incorporation of processing functionality for Sentinel-1 StripMap images into the LiCSAR processing chain. StripMap images are acquired for remote islands that may not be covered by the TOPS acquisition mode (Sentinel-1's main acquisition mode). Those volcanic islands imaged in StripMap mode include La Réunion (French territory, Indian Ocean), Fogo (Cabo Verde), Tristan da Cunha (British Overseas Territory, south Atlantic Ocean) and Marion Island (South Africa, sub-antarctic Indian Ocean). The processing produces multi-looked interferograms at ~30x30 m resolution. Each new image leads to the generation of three new interferograms, formed using the latest previous three images. Both wrapped and unwrapped images are provided, along with coherence maps (see Figure 6 for an example).
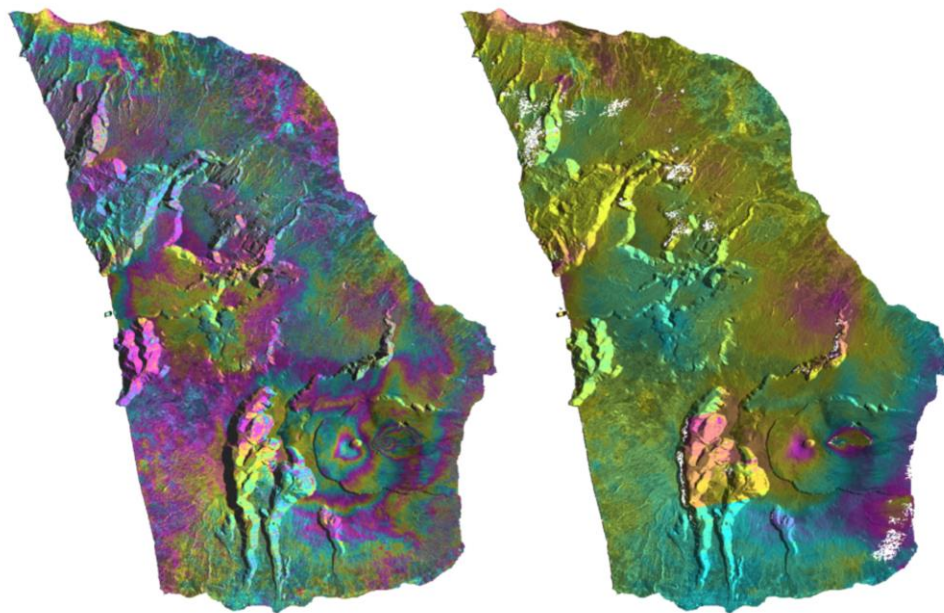
Figure 6. *StripMap interferogram for La Réunion from Sentinel-1 images acquired on 1st and 13th October 2020, downloaded from https://comet.nerc.ac.uk/comet-lics-portal . Left, with wrapped phase and right, with unwrapped phase.*

UNIVLEEDS has also opened access to a second volcano-based portal:

https://comet-volcanodb.org/

This portal provides results from the Sentinel-1 over selected volcano for each acquisition geometry of the Sentinel-1 satellites. Examples of products are shown in Figure 7. The data are available in GeoTiff and PNG formats, according to EPOS standards. Currently data from a selection of volcanoes are available through the portal to the general public and login access is required to access the whole database.
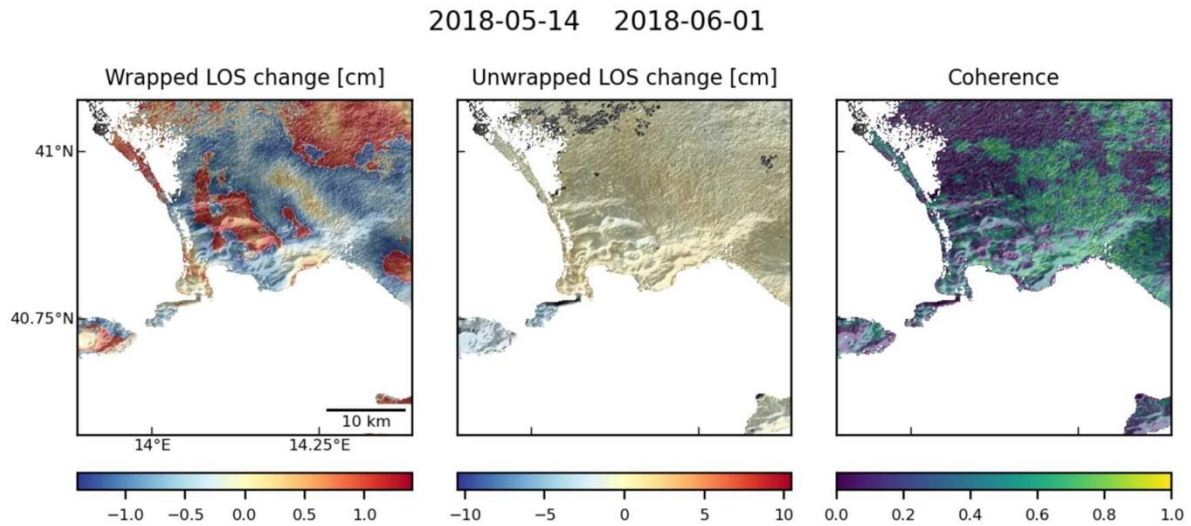
Figure 7. *Example of a cropped interferogram, wrapped and unwrapped and coherence map for Campi Flegrei. This is one track (Descending Track 124) of three for Campi Flegrei.*

Also provided in the portal is an atmospheric correction product, generated from the Generic Atmospheric Correction Online Service for InSAR (GACOS), also available in GeoTiff and PNG formats, according to EPOS standards. Figure 8 shows an example.
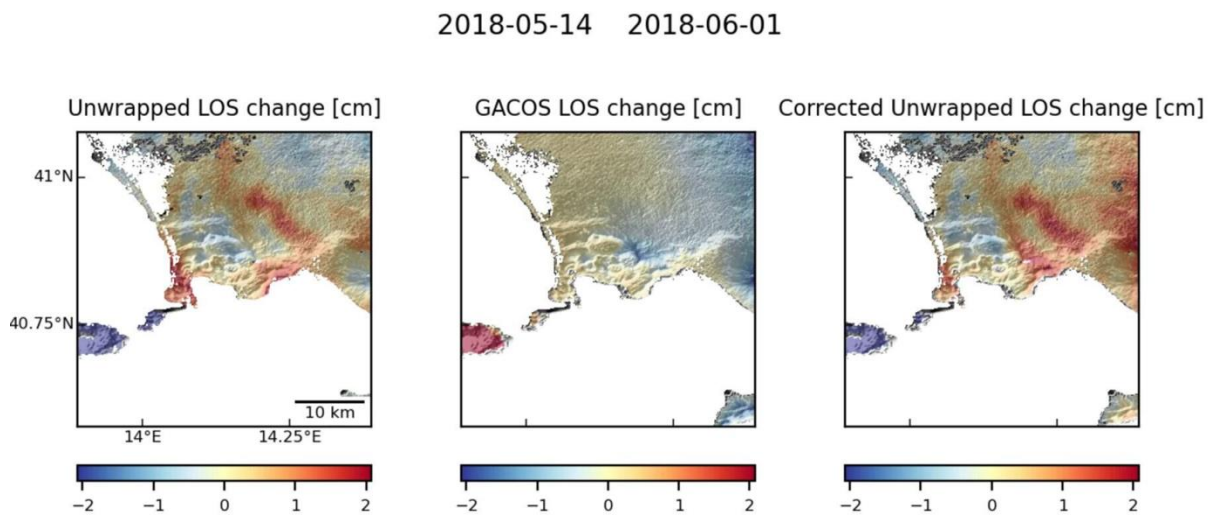
Figure 8. *Example of an atmospheric correction using the for Campi Flegrei. This is one track (Descending Track 124) of three for Campi Flegrei.*

A higher-level product provided by the portal is a time series product (Figure 9). The mean displacement rate, at a resolution of 1 x 1 km, for each track covering the volcano can be downloaded as a CSV file. Time series for individual, or multiple, points can also be plotted and downloaded as a CSV file.
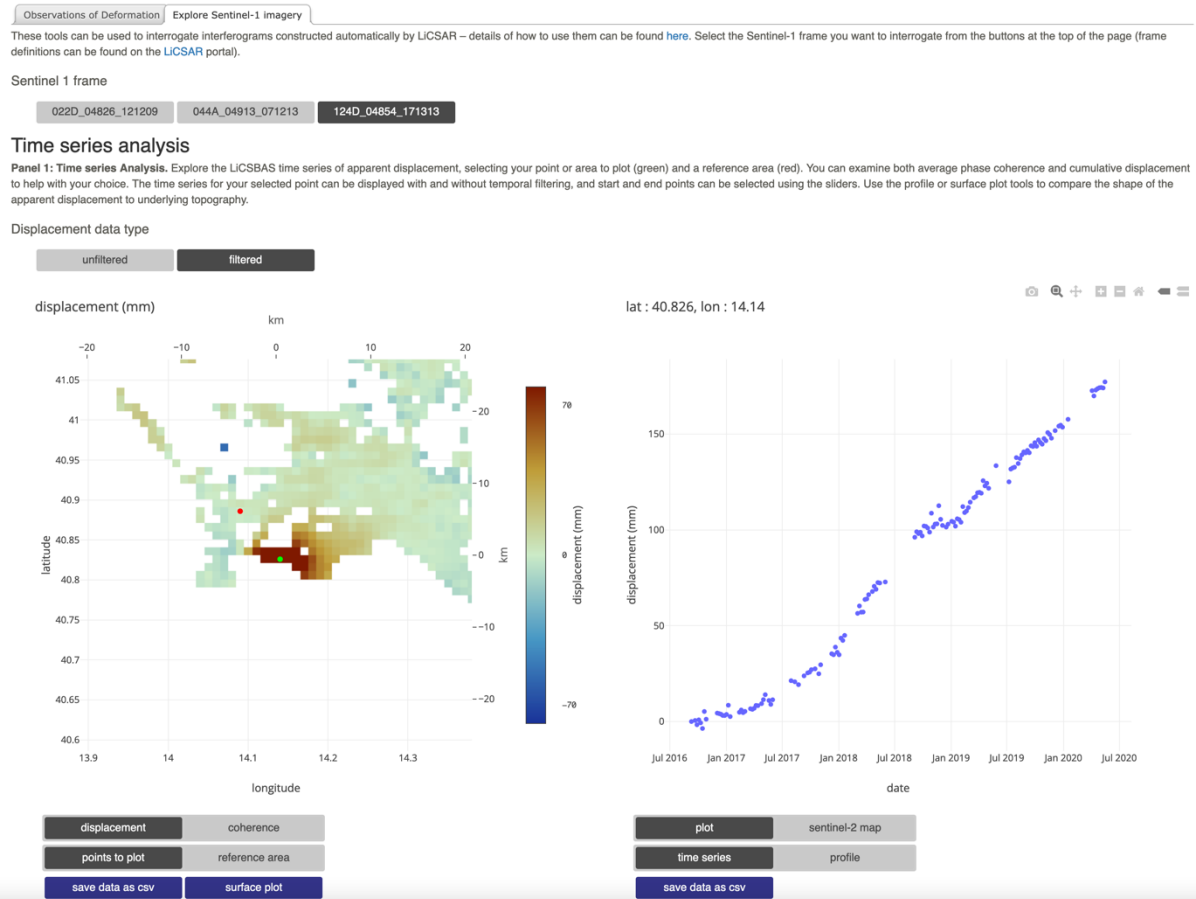
Figure 9. *Example of a time series product for Campi Flegrei. Both reference and points to plot can be specified separately, with an option to filter the time series.*

Data are currently available for 178 priority volcanoes, defined by the Powell Volcano Working Group: http://www.geo.cornell.edu/eas/PeoplePlaces/Faculty/matt/powell/

These are volcanoes that have erupted since 1990 in populated regions with PEI (Population Exposure Index) ≥ 2, or eruptions anywhere from 2014–2019 (Figure 8).

Figure 9. *Number of interferograms available for each subaerial volcano. 178 priority volcanoes currently have data.*

Seismic data sets

Example of a seismic data set networked by EUROVOLC partners is the data, provided by partner DIAS, from a seismic array data for monitoring and tracking tremor sources during subglacial floods and volcanic eruptions at Vatnajökull ice cap, Iceland.

A metadata sheet was created containing information for seismic array data that were collected during the 2014-2015 activity in Bárðarbunga volcanic system, Iceland (within the FUTUREVOLC project). A FDSN (Federation of Digital Seismograph Networks) network code (5L) was created for the data on the DIAS EIDA (Eurpean Integrated Data Archive) node at the GFZ centre. Network codes are also assigned by the FDSN in order to provide uniqueness to seismological data streams.

A copy of the data was created so that all the data files (in miniseed format) carry the 5L network code. A metadata sheet with additional information about the data was submitted to GFZ and uploaded to a DIAS EIDA node. This metadata contains full details of the dataset including: the type and dates of the deployment, the owning institutions, and terms of use, as well as a fuller description and abstract with related publications.

The data and information is accessible at:

http://doi.org/10.14470/0Y7568667884

https://geofon.gfz-potsdam.de/doi/network/5L/2013

as shown in Figure 10 below.
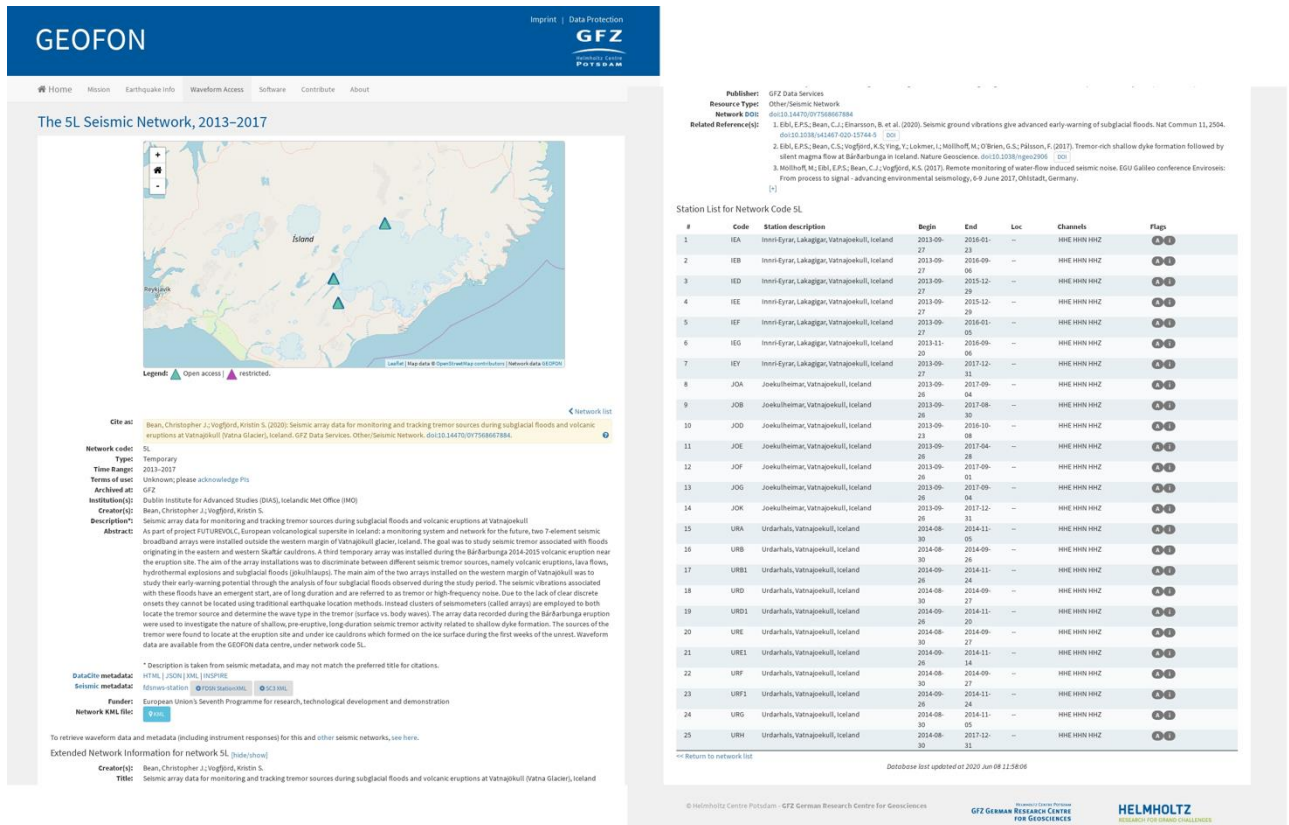
Figure 10. *Screenshot of metadata information for the 5L network of the DIAS EIDA node on the GFZ GEOFON website.*

The data is networked to the GFZ Potsdam data service website via the Data center section under the network code 5L, and the data are accessible in a unified way through FDSN web services and SeedLink. Instructions to search for and retrieve the waveform data and metadata (including instrument responses) from the GFZ Seismological Data Archive (GEOFON) are available at: https://geofon.gfz-potsdam.de/waveform/

Data Format: SeedLink real-time data comes in 512 byte Mini-SEED format. Archive data shipments in 512 or 4096 byte SEED format. Instrument response information as FDSN StationXML is available through the WebDC3 portal or as SeisComP XML from network pages. In addition, instrument response information as Dataless SEED volumes (or SeisComP XML, coming soon) response files are available through the WebDC3 portal.

Example data usage: The dataset contains two 7-element seismic broadband arrays that were installed outside the western margin of Vatnajökull glacier, Iceland. A third temporary array was installed during the Bárðarbunga 2014-2015 volcanic eruption near the eruption site. The array data recorded during the Bárðarbunga eruption were used to investigate the nature of shallow, pre-eruptive, long-duration seismic tremor activity related to shallow dyke formation. The sources of the tremor were found to locate at the eruption site and under ice cauldrons which formed on the ice surface during the first weeks of the unrest. An example of the waveform for such a tremor signal, taken from Eibl et al., (2017), is shown in Figure 11.
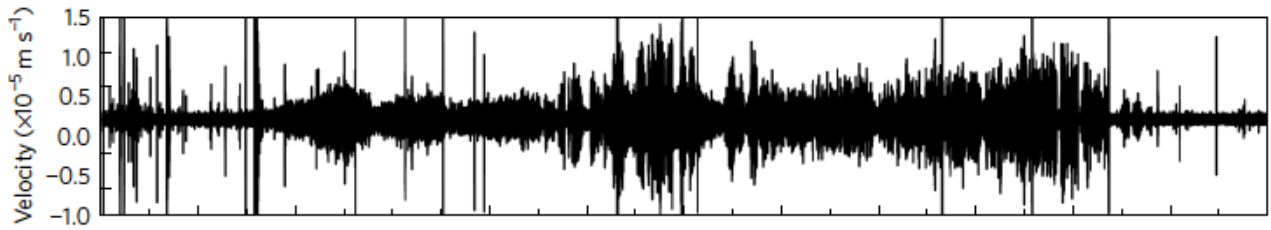
Figure 11. *Instrument-corrected seismogram of the vertical component at station URA of UR array filtered between 0.4 and 2.6 Hz, on 3 Sept 2014, showing an example of the tremor signals associated with shallow dyke formation.*

Another seismic data set networked by EUROVOLC is data from the Azores, networked by partner CIVISA. The data is from two seismic stations on the São Miguel island, Azores, that is now open access and available in the GEOFON archive at GFZ (GeoForschungsZentrum, Germany): https://geofon.gfz-potsdam.de/waveform/archive/network.php?ncode=CP

The FDSN (Federation of Digital Seismograph Networks) network code used for the data is CP. The two seismic stations are MESC and SET3, that belong to the permanent seismic network operated by CIVISA. The procedure to prepare and upload the data is the same as for the data set networked by DIAS.

For the archive data, the mseed files that existed in the CIVISA continuous database were made available by ftp, and manually inserted by GFZ on their data servers.

For the real-time data, it was necessary to install the *Ringserver* in the CIVISA server, which receives the real-time data from the seismic stations and makes it available for the GFZ servers, so they can retrieve it automatically. The instrument response information is available through the WebDC3 portal: http://eida.gfz-potsdam.de/webdc3/

Figure 12 shows the opening page for access to this data set.

Figure 12. *Screenshot of metadata information for the CP seismic network on the GFZ GEOFON website.*

Lava flow mapping

Partner UCA developed a procedure dedicated to the lava flow characterization consisting in mapping both the spatial extension and the thickness of lava flows from InSAR data, and incidentally in estimating the ground surface displacement related to the lava flows (Hrysiewicz, 2019). The procedure is based on the exploitation of inteferometric coherence maps to delineate the lava flows margin and estimate their surface area. In a first step, a preliminary lava flow map is created using a combination of morphological operators and optimal thresholding of the coherence images. The resulting preliminary map is used to estimate the probability, for each pixel belonging to the lava flow or to the background. Then, in a second step, from this probability, a mean lava flow map is calculated using a boot-strap approach. From this mean lava flow map, a mean area estimate for the lava flow is evaluated and a standard deviation that provide an uncertainty estimation on the lava flow area. A map is produced where each pixel is assigned a probability of being a part of the lava flow contour (see Figure 13 for an example).
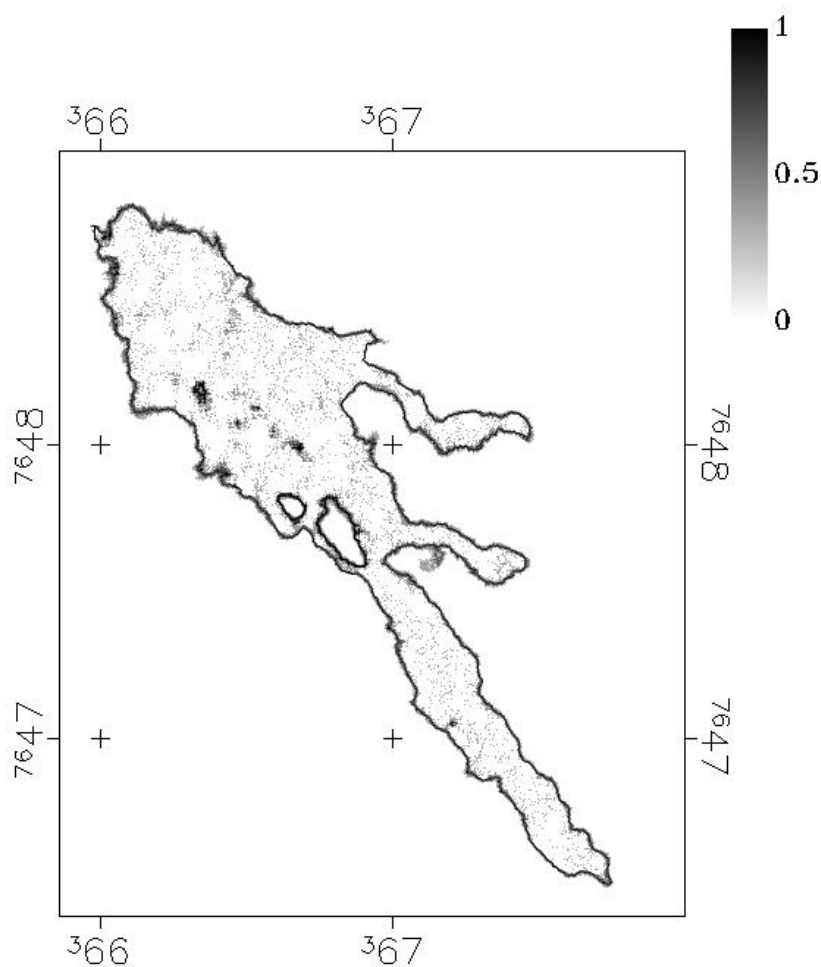
Figure 13. Map of the lava flow contour (0 = 0 % 1 = 100 % probability) for the July 2017 lava flow at Piton de la Fournaise.

Citizen science data tools

In relation to work carried out in WP12 and WP20 in EUROVOLC, partner NERC identified that citizen science data collected from a variety of existing volcano-related tools across Europe is not currently included in the Volcano Observatory TCS for EPOS. A new EUROVOLC tool (WP12) that harmonises data from these existing citizen science tools was created and we recommended a) that citizen science be more encouraged within each TCS of the wider EPOS community as a way to enable the work of that community, and b) that EPOS could adapt a broader concept of "citizen Science" across disciplines under the broader heading of Earth Sciences which will pull in a broader target group and data reach to compliment the more formal EPOS platform. Since citizen tools are relatively new, inclusion of such products into EPOS-IP requires preparatory work that was carried out. British Geological Survey (BGS), as a part of NERC, plans to join the EPOS TCS Volcano Observations as more data is collected for Ascension Island and Tristan da Cunha. KMT networking ideas were developed.

Other work

Partners IMO and UI carried out work to network data in relation to eruptions in Iceland, reported in deliverable report 6.3.

In addition to work described above, INGV focused on harmonizing the structure of metadata associated with the following data types: i) groundwater temperature (DDSS-013); ii) GNSS time series measured at Etna from 2000 to 2008 (DDSS-030); iii) map of recent and past lava flow for the historic activity of Etna (DDSS-034).With regard to DDSS-013, DDSS-030 and DDSS-034, data have been archived in a database, named TSD System, which works at Osservatorio Etneo in Catania, exclusively for the management of INGV activities. Starting from these datasets all necessary information will be provided to Work Package 20 (WP20 Virtual Access to EPOS VO-TCS) IT staff in order to create the necessary tools to make the current dataset discoverable within EUROVOLC Gateway Portal and compliant with EPOS standards, through the Volcano Observations - Thematic Core Service (VO-TCS). Further details can be found also in WP20 reports.

Partner HSGME continued to collect date at Santorini and other volcanoes in Greece. Seismic, GNSS and physicochemical data are available, and steps have been taken to network these data sets.

References

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