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PRELIMINARY ACTIVITY FOR IDENTIFICATION AND CHARACTERIZATION OF AN INTERNATIONAL CAL/VAL SITE

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Introduction

During the four years Italian Space Agency (ASI) funded project "ASI-AGI" (Analisi Sistemi Iperspettrali per le Applicazioni Geofisiche Integrate) INGV has developed specific algorithms and products for various geophysical applications to be applied on hyperspectral data that will be acquired during lifetime of the next ASI-PRISMA (Precursore IperSpettrale della Missione Applicativa). PRISMA is a pre-operative small Italian hyperspectral mission aiming to observe routinely and to characterize the earth surface by coupling an hyperspectral and a panchromatic sensor. In this context ASI-AGI project contributes to develop applications and provides products to institutional and scientific users for environmental observation and risk management.

Moreover the identification of a CAL/VAL site is a direct interest of European Space Agency (ESA) in the framework of the Committee on Earth Observation Satellite (CEOS) actions. The scope of this project is to select, identify and characterise test sites, to be used as a reference, for the calibration and characterisation of different sensor types and identifying and characterizing test sites that can be used for external calibration. The project is part of the ESA strategy for ensuring the quality (in terms of calibration, validation and operational quality) of data developed for current and future missions within the Explorers and he European Earth observation programme Copernicus, previously known as GMES (Global Monitoring Environment and Security) framework. The choice of a sites or the use of a site depends on the nature of the space mission (ocean color, terrestrial biosphere), by the sensor resolution (high medium or low spatial resolution), and then on the needs to produce reliable information in terms of accuracy and stability. In this context from May 6th and 11th, 2014 INGV has performed a pre-survey for the identification and characterization of a vicarious calibration-validation remote site supporting the future ASI space missions. This field campaign has been conducted in Algeria in the Western Sahara region, in the Bechar province, more precisely in the area ranging from Ougarta and Beni Abbes. While the CAL/VAL activities of ASI-AGI project have been already described in Colini et al., [2014] this report describes the activity done during the dedicated field campaign aimed to identify a new vicarious test site in North Africa in the Algerian desert. In the follows, we present the region Ougarta, its location, the overall field campaign organization, geology and sites description that have been measured in the framework of this project.

All these information are required in order to verify the compliance of the chosen site with the retained criteria expressed in Berthelot and Santer [2008]. The level of compliance will allow the characterization of inland calibration-validation site as:

LES: Land Equipped Site
LNES: Land Non Equipped Site

Equipped sites correspond to a test sites and are adapted for Optical sensor medium resolution and geostationary instruments. They can be used for Optical sensor high-resolution sensors as well. Because of high radiometric requirements, class 2 sensors can be used as reference for cross calibration with class 3.

1. Objective of field campaign and Surface Geology

With the scope of exploring the possibility to set up a new CAL/VAL test site, INGV has organized and deployed a field campaign in the Bechar province. This survey was necessary for acquiring the parameters needed for CAL/VAL site identification and characterization of possible vicarious sites for external calibration. Such activity has been performed with the specific interest toward the incoming ASI-PRISMA space mission. With the intention of verifing the suitability of a specific site and according to Berthelot and Santer [2008] the following information have to be provided in order to define the proper affiliation class (Table 1):

Questionnaire Content Description	LES	LNSE
Site location	x	x
Logistic information	x	
Site climatology	x	x
Calibration methodology		x

Questionnaire Content Description	LES	LNSE
Site instrumentation	x	
Measurement accuracy	x	
Site usage	x	x
Sampling strategy		x
Contact information	x	x
Data availability	x	x

Table 1. Information content of questionnaires needed for site class definition.

This table lists the preliminary requirements that should be analyzed in order to define the type of inland calibration-validation site that can be instrumented and eventually improved.

More in detail:

1. The **site location characterization** requires information concerning surface in terms of:
   - **Altitude**; the site should be located at high altitude (to minimize aerosol loading and the uncertainties due to unknown vertical distribution of aerosols), far from the ocean (to minimize the influence of atmospheric water vapour), and far from urban and industrial areas (to minimize anthropogenic aerosols).
   - **Morphology**; the surface of the site should be flat to minimize slope-aspect effects, at different scale.

2. The **site logistic information** requires information concerning the distance from nearest city.

3. The **site climatology** requires information concerning :
   - **Spatial uniformity**; the site should have high spatial uniformity, relative to the pixel size, to minimize the effects of scaling radiometric data to the size of the entire test site. The site should also be centred in an area large enough to accommodate the sampling of a large number of pixels and to minimize atmospheric adjacency effects due to light scattered from outside the target region.
   - **Surface reflectance level**; inland terrestrial site should have a surface reflectance greater than 0.3 in order to provide higher signal-to-noise ratio (SNR) and reduce the impact of atmospheric errors.
   - **Spectral variability**; the surface of the site should have as much as possible flat spectral reflectance.
   - **Invariance of spectral and radiometric properties;** the surface properties of the site (reflectance, BRDF, spectral properties) should be temporally invariant. This implies that the site should have little or no vegetation**.**
   - **Magnitude of directional effects**; the surface of the site should be horizontal and have nearly Lambertian reflectance to minimize uncertainties due to differences in solar illumination and observation geometries.
   - **Cloud cover**; the site should be in an arid region to minimize the probability of cloudy weather. The low probability of cloud coverage also increases the probability of the optical instruments sensing the test site at the time of overpass.
   - **Aerosol, water vapor and ozone**; to avoid sites where these factors are absorbing and variable in time and space.

4. The **site usage** requires information concerning the availability of historical record or regularity of satellite acquisition.

5. Concerning the **instrumentation** collection of information ranging from instrument names, wavelength, parameter measured, measurement accuracy and precision, calibration standard.

All the in situ field surveys, analysis and measurements have been performed to respond to the above-mentioned requirements for a correct proposition of a new CAL/VAL site.

The region of Ougarta Beni Abbes is located 300 km SS-W from the town of Bechar in the western

“Grand Erg”. Around Beni Abbes and its region, is present a geo-ecosystem (Figure 1), which represents the last stage of a long geological history initiated here more than 600 million years ago.

The chain of Ougarta is in a joint position between two areas of different age. The first is the African Western Craton towards 2000 M.A. The second is the Touareg Shield. It is located on the conjunction area, resulting from the collision between the passive margin of African Western Craton, and that activates of an Eastern continent connects to the operation of a zone of decked subduction towards the east [Liegois et al., 1988].

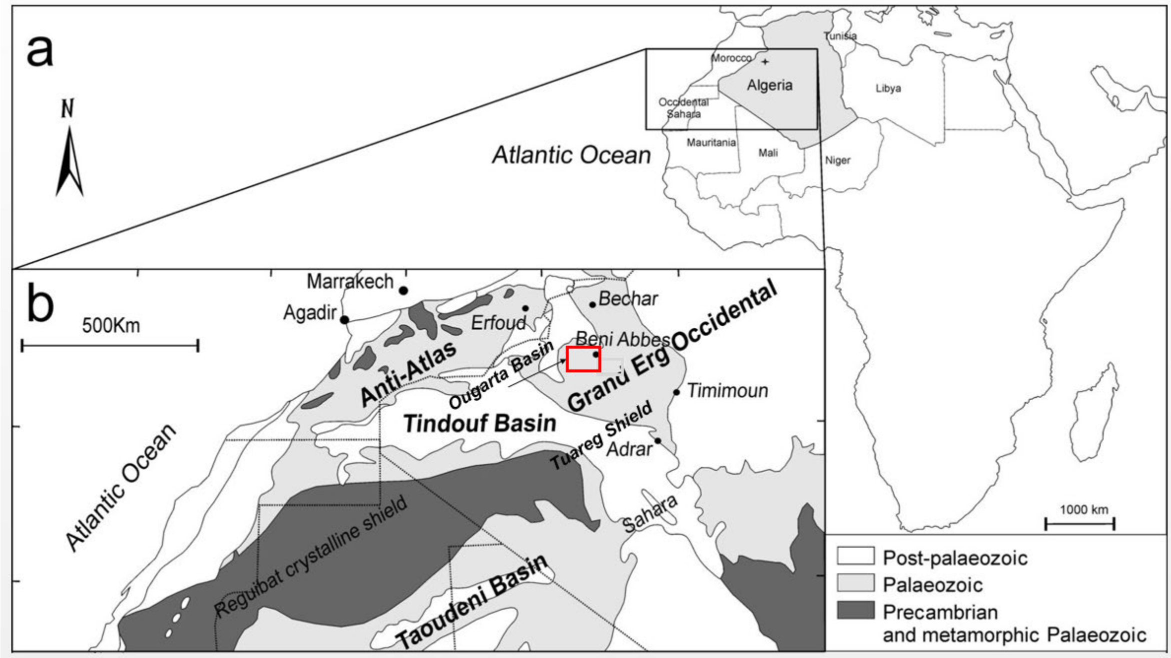

Figure 1. Geographic location (a) and geological sketch map of the western Algeria (b) and synthetic log of the Paleozoic and Precambrian succession. The red square indicates the Bechar area (see Figure 2).

The chain of Ougarta consists of a set of volcanic formations and volcano-detrital, on which lays in discordance connect a thick sedimentary cover of Paleozoic age primarily Cambro-ordovicien presenting at its base a polygenic conglomerate with known element under the name of “conglomerate of Ben tadjine” [M. Chikhaoui and M. Donzeau, 1972]. All the grounds of Pre-Cambrian ages appear in the form of buttonholes of erosion in the sedimentary cover, in the heart of the anticlines [Chikhaoui, 1974].

2. Test site description

During the field campaign seven sites have been analyzed (Figure 2, Table 2) in order to understand the variety of outcropping rocks and their aerial coverage. These information are needed for defining the observability of such surfaces from satellite. This analysis cannot be considered close and further investigation on salty areas is foreseen. A brief surface description of the investigated sites is reported, while for a more accurate review refer to Nedjarj et alii, 2007 and included bibliography.

Table 2 shows the names of the measuring points and the number of spectra acquired.

Site name	Latitude	Longitude	Number of sample
Ougarta 1	29.83573 N	2.24485 W	230
Ougarta 2	29.65372 N	2.26165 W	300
Ougarta 3	29.77440 N	2.25335 W	480
Ougarta 4	29.71355 N	2.26548 W	800
Ougarta 5	29.94992 N	2.21901 W	290
Ougarta 6	29.96527 N	2.07047 W	210
Ougarta 7	29.60723 N	2.25835 W	340

Table 2. Collected sites, with long. and lat., and number of spectra acquired.

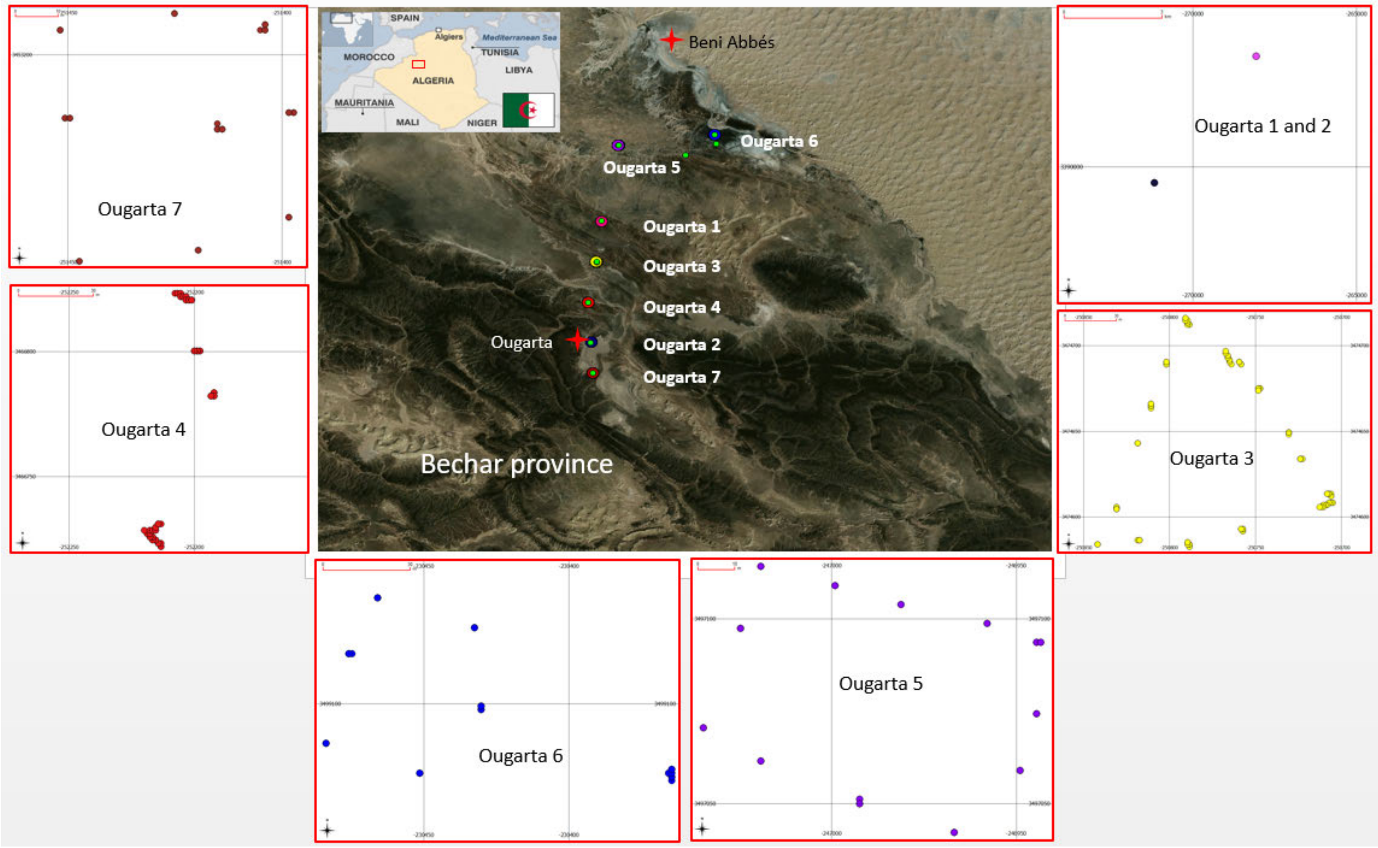

Figure 2. Bechar Area and sites localization; inset shows the relative distribution of collected points.

Site Ougarta 1:

Reg. of mid Devonian age made of silty clay set above the limestone level also known as Great Wall of China (Figure 3).

Figure 3. Site Ougarta 1: Mini reg with silty elements of Devonian, limestone clasts of Hamada and aeolian sand grains.

Sites Ougarta 2 and Ougarta 7 "*sebka d'Ougarta*":

The surface of the sebkha shows a relative homogeneity. It consists of surface deposits for low density and cohesion, combining wind and sand evaporites (gypsum and sodium chloride). In the Saharan literature they are called "Fech Fech". Direct observation shows a centimeters thick halite crust with tepee growth-related salts. An eolian sands moved by the wind from near the Western Erg fill the crack in a gypsum matrix. The altered Silurian shales appears underneath (Figure 4, Figure 5).

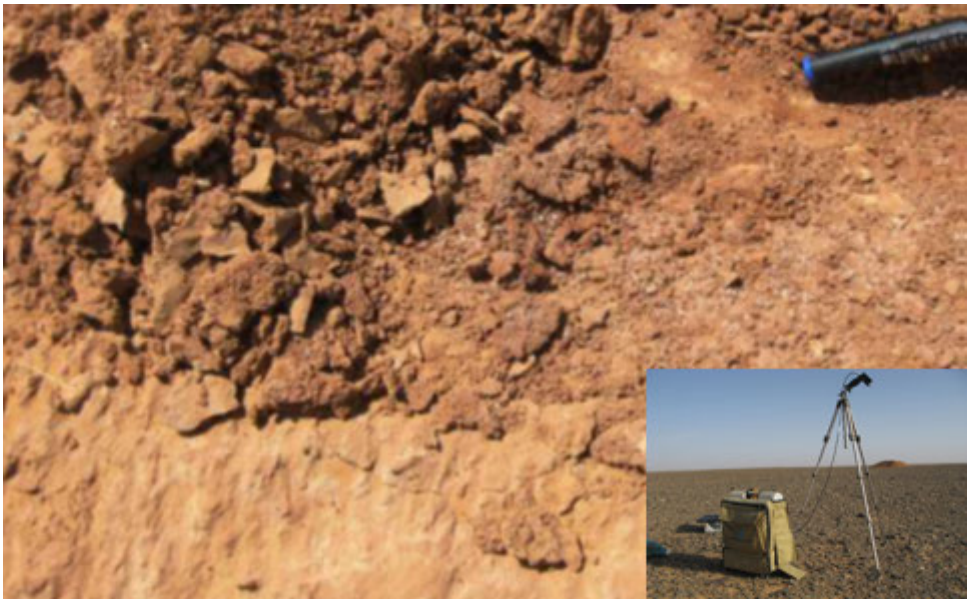

Figure 4. Site Ougarta 2:Sediment in the sebkha, type fech predominantly sandy evaporite.

Figure 5. Site Ougarta 7: Halite crust cm with tepee and blistering growth-related salts. A sand aeolian with wind-blown sand from the nearby Western Erg in a gypsum matrix. Below Silurian shales altered.

Site Ougarta 3:

It is composed by calcareous dolomite, with a little quartz clasts, containing silica on the top. Clastic elements are made of heterogeneous angular quartz (10 to 400µ in diameter) and few micor clast of silica. The newly formed silica appears in the form of micro clast of crystalline quartz with calcite or dolomite cryptocrystalline (Figure 6).

Figure 6. Site Ougarta 3: Mini reg developed on Silurian black shales covered, Neogene located in the east of the road to the village Ougarta.

Site 4 Ougarta:

It is a reg whose elements range from centimeters up to decimeters made of dismantled lower Devonian, levels of sandstone, quartzite and sometimes millimeters silts beds. The bottom is formed by the windy sand and clay (Figure 7).

Figure 7. Site Ougarta 4: Reg whose elements are from cm to dm dismantle the Lower Devonian (middle) of sandstone levels, sometimes quartzite and siltstone beds mm to cm. The bottom consists of aeolian sand or clays.

Site Ougarta 5:

This is the plateau near Beni Abbes. This platform is developed on the silicified limestone formation that caps the Hamadiennes formation (Tertiary continental terminal complex) with two of silicified carbonate levels. They are hard ground (8m and 2m respectively) on which a vast rocky plateau is developed. In these paleosols formations iron nodules and carbonate accumulations, are observed (Figure 8).

Figure 8. Site Ougarta 5: Wind-blown sand or clays form Reg with elements cm/dm from the dismantling of Lower Devonian (middle) of sandstone levels, sometimes quartzites and silt beds mm to cm.

Site Ougarta 6 "*Calcaires griottes*":

These are nodular limestone layering with centimeter up to decimeter thickness. Minor nodules are embedded in a clay-ferruginous matrix. Nodules are a carbonate clast. The silt clay fraction is low (Figure 9).

Figure 9. Site Ougarta 6: Nodular limestone ("Calcaires griottes") benches cm to dm. The nodules are embedded in cm a clay matrix. Nodules are composed by carbonated to micrite bioclast. The fraction silt clay is quite low.

According the data contained in literature [Liegois, 1988; Chikhaoui and Donzeau, 1972; Nedjarj et al., 2007] and to the direct observation, all these sites respond to **site location characterization** and **site logistic information** requirements reported in the previous section.

3. Surface spectral characterization

For the definition of the level of compliancy with respect to site climatology requirements, surface spectral measurements have been performed over the seven investigated sites.

Measurements of solar reflected radiance were carried out with an Analytical Spectral Device (ASD) FieldSpec pro portable spectroradiometer (Analytical Spectral Devices, Inc., 1994). Three separate spectrometers cover the 350-2500 nm spectral range respectively 1 in the VNIR and 2 in the SWIR region. Measurements were made directly with the bare fiber-optic cable, which has a field of view of 25°with and a portable Garmin GPS recording the coordinate for each spectrum in National Marine Electronics Association format (NMEA0183) (Figure 10 and Table 2). The instrument operability is described in ASD [1994], afterwards updated, which also describe the characteristics needed to fulfill the requirement concerning the instrumentation as reported in section 1.

Measures of reflectances have been collected on 6^{th},7^{th}, and 8^{th} May 2014 and during these days the wheater was excellent and totally cloud free allowing the data collection over 7 different sites (Figure 2).

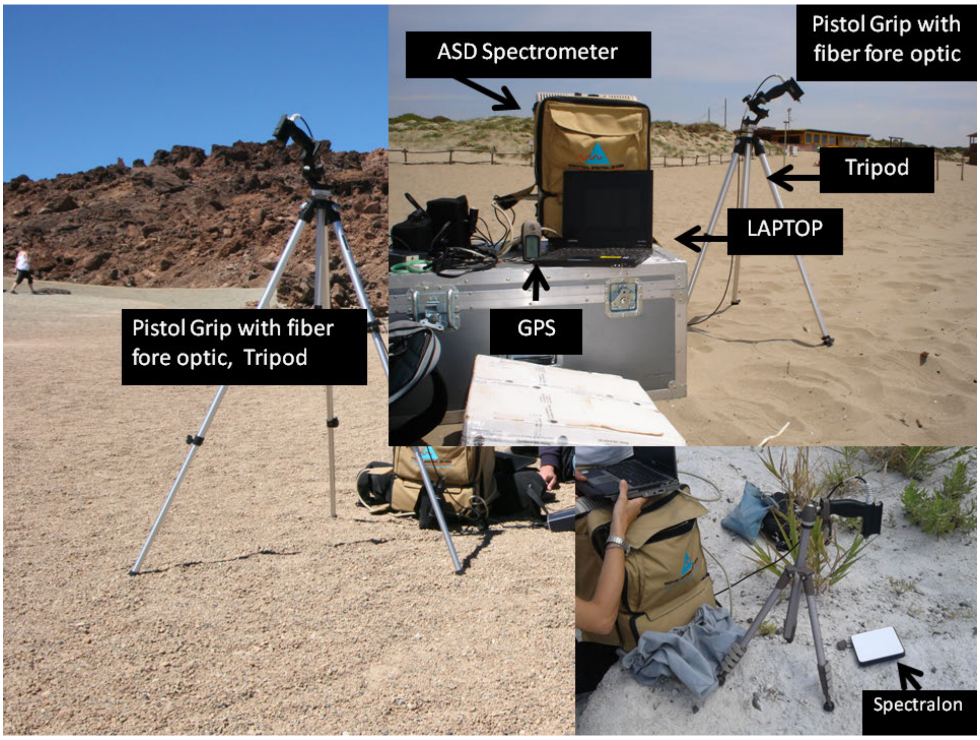

Figure 10. ASD FieldSpec Pro mission set up.

All sites have been acquired by following the same methodology: a tripod has been used to maintain the distance between fiber fore optic and target constant as much as possible. This distance has been maintained constant also among different sites. The fiber fore optic has been pointed toward the target with a same angular inclination of the solar incidence but in opposite direction (Figure 11).

The number of collected sample was 30 for each point. Not less than 8 points compose a site. Ougarta 1 and 2 sites are represented by only one point due to a wrong operation of the GPS (inset in Figure 2).

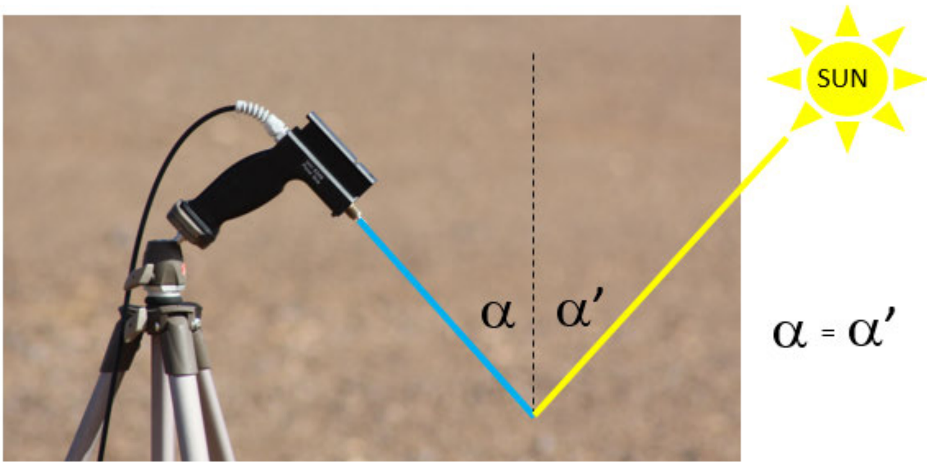

Figure 11. Bare Fiber Fore optic pointing schema (not in scale).

The analysis of the collected spectra (Figure 12) shows that sampled sites have similar trend but different absolute value. Ougarta 6 has to be considered not suitable at all for CAL/VAL purposes due to its very low reflectance value with respect to the threshold defined in Berthelot and Santer [2008]. Ougarta 1, 3 and 4 have several spectral range below the indicated threshold both in the VNIR and SWIR spectral region. Ougarta 2, 5 and 7 have only the initial part of the spectra below this threshold. Ougarta 2 and Ougarta 7 have the same reflectance spectra with a difference less than 2%.

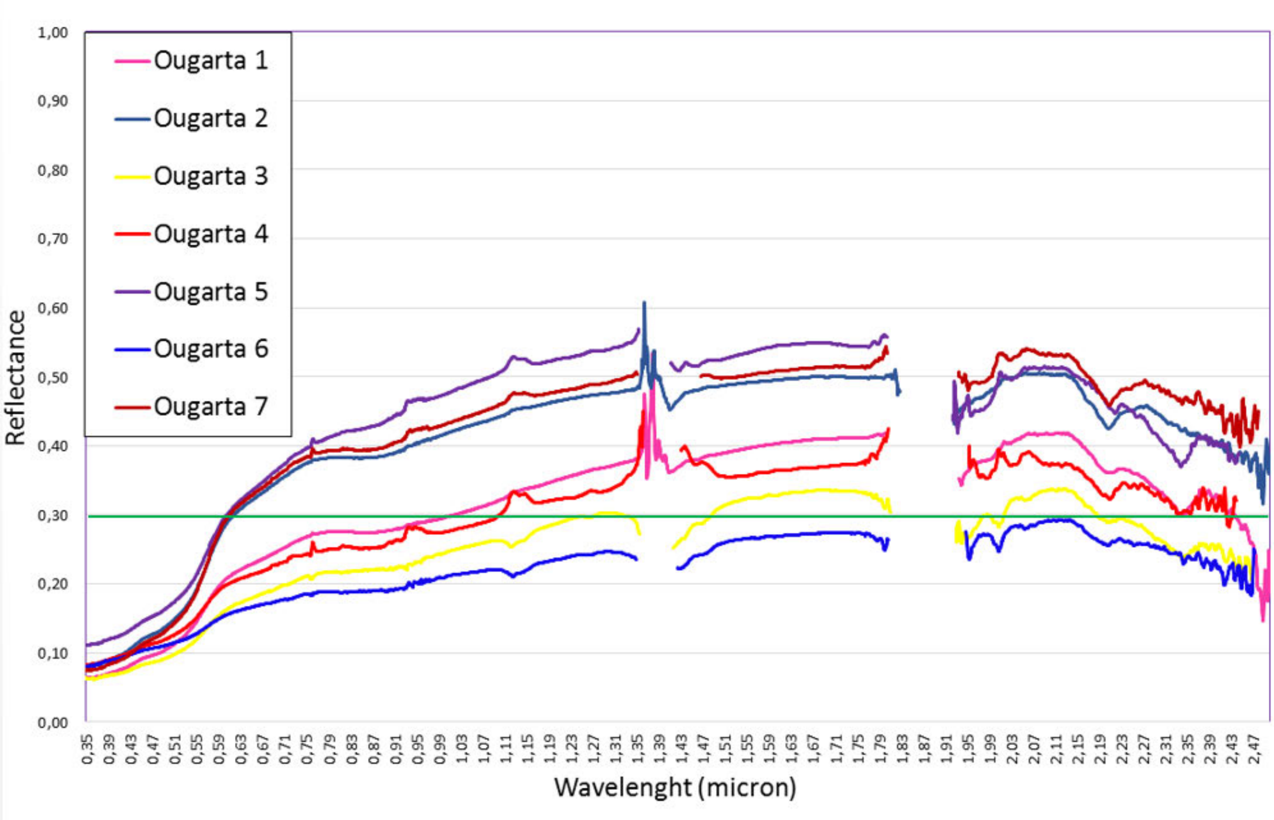

Figure 12. Fieldspec ASD, reflectance measurement. Horizontal green line is the reflectance threshold defined by Berthelot and Santer [2008].

4. Photometric Measurement

During the CAL/VAL campaign, sun-photometric measurements were performed in different places in order to characterize the atmospheric particulate in coincident to surface spectral measurements.

The sun-photometer has been operated during the field campaign providing direct solar irradiance measurements at 5 different wavelengths from UV to near IR (440, 675, 870, 936 and 1020 nm). The sun-photometer provides the aerosol optical depth (AOD) at each wavelength from the surface up the Sun looking toward the atmosphere [Holben et al., 2001], along with the water vapor column content at different wavelengths. A big amount of information about the optical and microphysical aerosol properties, such as the refractive index and the aerosol size distribution is also systematically retrieved from the sun-photometer measurements, and these information are necessary for the atmospheric characterization in the surface spectral retrieving process, basic activity for a CAL/VAL test site definition.

The sun-photometers used is the portable MICROTOPS II model Solar Light (http://fsf.nerc.ac.uk/instruments/sunphotometer.shtml) owned by remote sensing laboratory belonging to the "Satellite data for Earth Observation" INGV-CNT Unit. The instrument is a Volztype photometer with a 2.5° field of view. Thanks to the reduced size it is largely used in field campaigns in different remote areas such as desert or volcanic areas.

In Figure 13 the instrument set up is reported whilst in the Figure 14 measurements executed are reported. A proper use of this instrument requires that its fore-optic heads to the solar disk and for such a reason the instrument, for human safety, has an indirect pointing system that can be easily handled by mounting the sun-photometer on a tripod. In this figure a sample of AOT measurements in 5 wavelength channel sampling the atmospheric column is shown.

Figure 13. Microtops sun photometer mounted on its tripod with connected GPS.

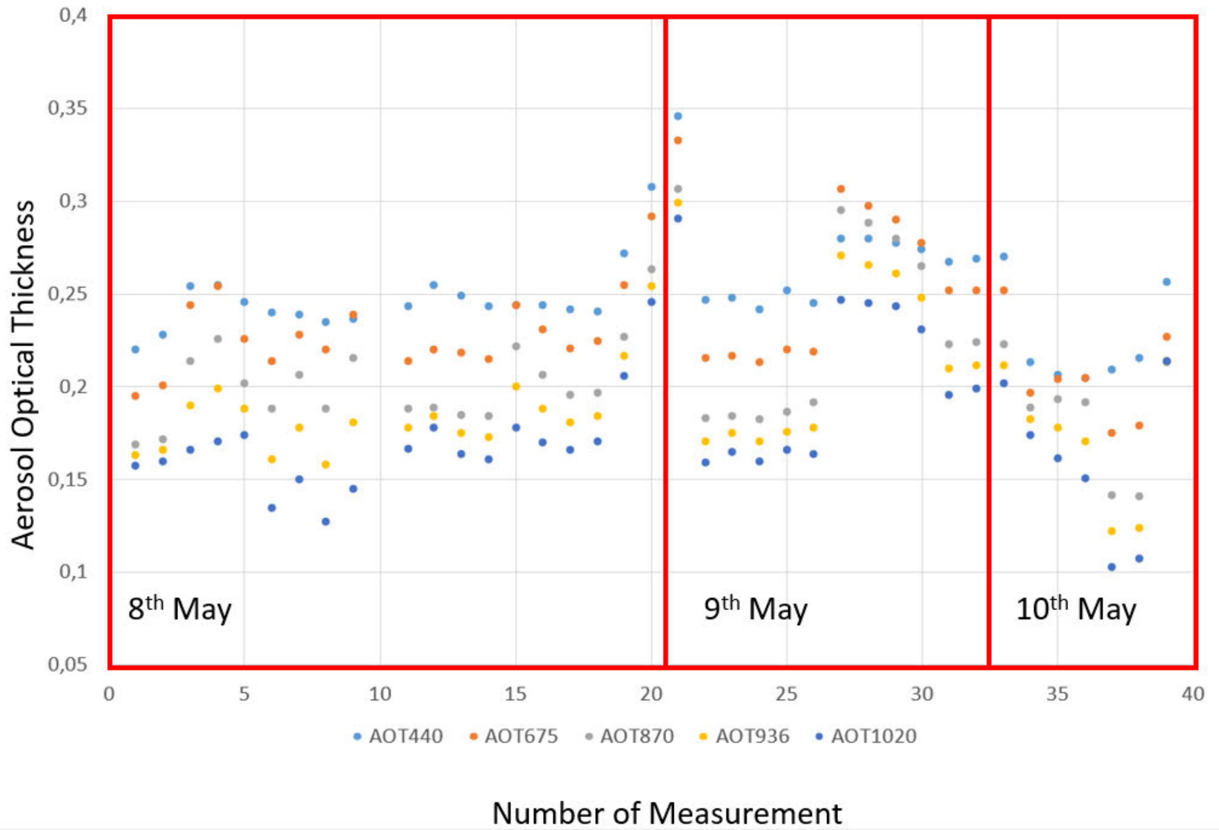

Figure 14. Photometric Measurement. Total optical thickness trend obtained by sampling the atmosphere by using Microtops sun photometer. The optical thickness is represented as a function of the wavelength measurements acquired on 8th, 9th and 10th May 2014.

5. Surface Temperature Measurement

Beside spectral sampling and photometric measurements, surface temperature measurements by using an Infrared Thermometer and Thermocouple Probe for contact temperature at soil level have been collected. Results of these measurements are reported in Figure 15 and Table 3.

This parameter is necessary for the proper retrieving of the surface spectral characterization. The most used radiative transfer model for atmospheric characterization, MODTRAN [Berk et al., 1989] needs as input information the atmosphere-surface interface temperature enabling the surface albedo retrieval, therefore it is better to directly measure the temperature rather than estimate or assume it referring to climatological.

Surface temperature variations have to be referred to the different acquisition time (see Table 3). The highest values have been measured around 4:30 PM and the lowest on 8:30 AM. Temperature acquired by means of "probe thermometer" is more constant and it is not affected by the wind or humidity as well as the temperature acquired by IR thermometer.

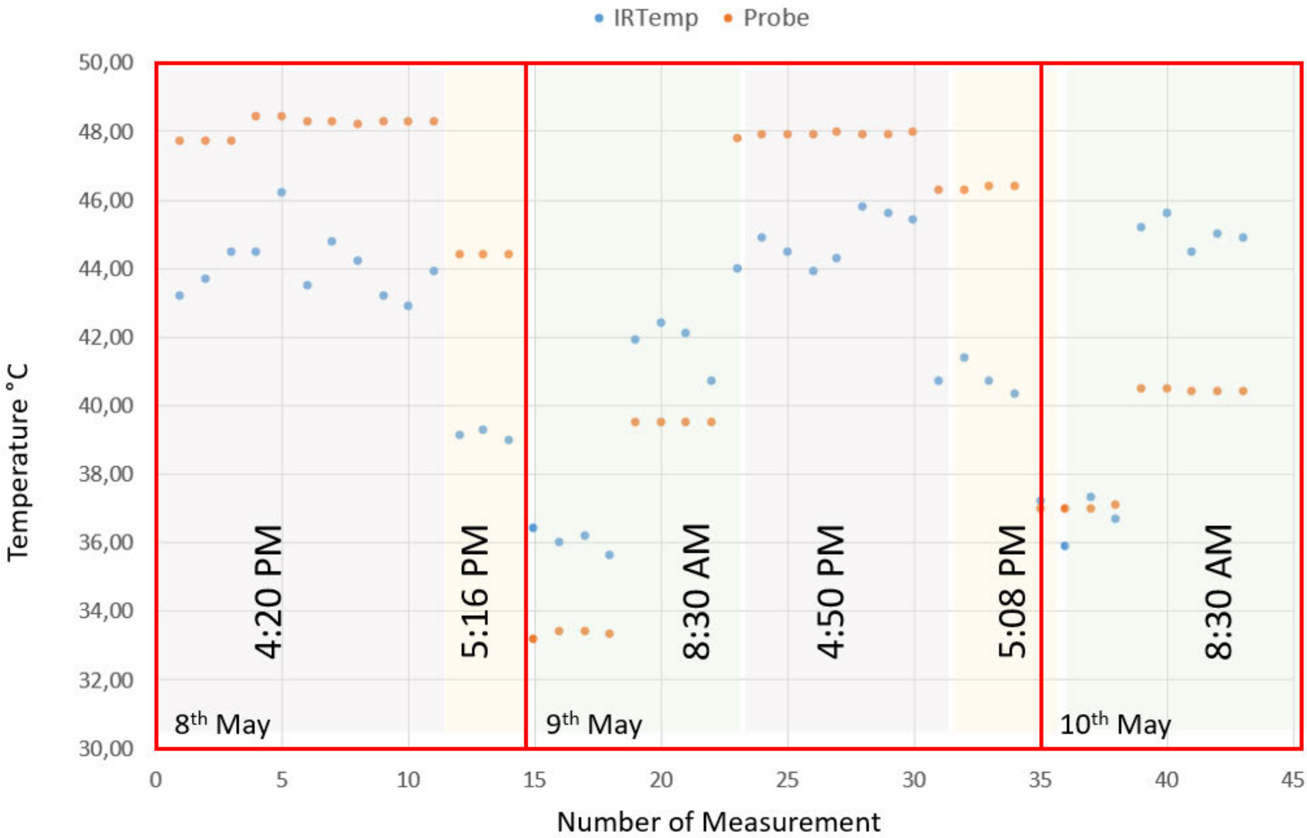

Figure 15. Surface Temperature measured by using Infrared Thermometer during the on 8^{th}, 9^{th} and 10^{th} May 2014 field campaign.

No	IRTemp	Probe	Date	Time	IRTemp	Probe
1	43,20	47,70	05/08/2014	4:13:39 PM	43,20	47,70
2	43,70	47,70	05/08/2014	4:13:45 PM	43,70	47,70
3	44,50	47,70	05/08/2014	4:14:10 PM	44,50	47,70
4	44,50	48,40	05/08/2014	4:21:58 PM	44,50	48,40
5	46,20	48,40	05/08/2014	4:22:03 PM	46,20	48,40
6	43,50	48,30	05/08/2014	4:22:08 PM	43,50	48,30
7	44,80	48,30	05/08/2014	4:22:20 PM	44,80	48,30
8	44,20	48,20	05/08/2014	4:22:30 PM	44,20	48,20
9	43,20	48,30	05/08/2014	4:22:35 PM	43,20	48,30
10	42,90	48,30	05/08/2014	4:22:39 PM	42,90	48,30
11	43,90	48,30	05/08/2014	4:22:42 PM	43,90	48,30
12	39,10	44,40	05/08/2014	5:16:07 PM	39,10	44,40
13	39,30	44,40	05/08/2014	5:16:14 PM	39,30	44,40
14	39,00	44,40	05/08/2014	5:16:23 PM	39,00	44,40
15	36,40	33,20	05/09/2014	8:28:18 AM	36,40	33,20
16	36,00	33,40	05/09/2014	8:28:44 AM	36,00	33,40
17	36,20	33,40	05/09/2014	8:28:48 AM	36,20	33,40

No	IRTemp	Probe	Date	Time	IRTemp	Probe
18	35,60	33,30	05/09/2014	8:28:54 AM	35,60	33,30
19	41,90	39,50	05/09/2014	8:54:18 AM	41,90	39,50
20	42,40	39,50	05/09/2014	8:54:21 AM	42,40	39,50
21	42,10	39,50	05/09/2014	8:54:25 AM	42,10	39,50
22	40,70	39,50	05/09/2014	8:54:31 AM	40,70	39,50
23	44,00	47,80	05/09/2014	4:52:02 PM	44,00	47,80
24	44,90	47,90	05/09/2014	4:52:06 PM	44,90	47,90
25	44,50	47,90	05/09/2014	4:52:11 PM	44,50	47,90
26	43,90	47,90	05/09/2014	4:52:16 PM	43,90	47,90
27	44,30	48,00	05/09/2014	4:52:21 PM	44,30	48,00
28	45,80	47,90	05/09/2014	4:52:30 PM	45,80	47,90
29	45,60	47,90	05/09/2014	4:52:33 PM	45,60	47,90
30	45,40	48,00	05/09/2014	4:52:39 PM	45,40	48,00
31	40,70	46,30	05/09/2014	5:08:36 PM	40,70	46,30
32	41,40	46,30	05/09/2014	5:08:41 PM	41,40	46,30
33	40,70	46,40	05/09/2014	5:08:45 PM	40,70	46,40
34	40,30	46,40	05/09/2014	5:08:50 PM	40,30	46,40
35	37,20	37,00	05/10/2014	8:31:32 AM	37,20	37,00
36	35,90	37,00	05/10/2014	8:31:38 AM	35,90	37,00
37	37,30	37,00	05/10/2014	8:31:42 AM	37,30	37,00
38	36,70	37,10	05/10/2014	8:31:46 AM	36,70	37,10
39	45,20	40,50	05/10/2014	8:58:18 AM	45,20	40,50
40	45,60	40,50	05/10/2014	8:58:23 AM	45,60	40,50
41	44,50	40,40	05/10/2014	8:58:27 AM	44,50	40,40
42	45,00	40,40	05/10/2014	8:58:33 AM	45,00	40,40
43	44,90	40,40	05/10/2014	8:58:39 AM	44,90	40,40

Table 3. Surface temperature measurement. Light grey, light green and light yellow indicates measurement performed at same hour in different days.

6. 3D modelling

The surface characterization, needed for 3D modeling, is aimed to analyze the spatial variation and distribution of outcropping lithology. This analysis is needed for understanding the illumination condition and then the shade or shadows effects to be considered in the relief-building model. This analysis allows to study the effects due to small scale "topographic" features on reflected and emitted energy in the VNIR-SWIR spectral range. Such interaction constraints better the atmosphere-surface relation for a suitable estimation of the surface reflectance during CAL/VAL activities.

For each site one or more 3D models of the surface (Figure 16; Table 4) have been reconstructed by using the "structure from motion" technique (Sfm). Sfm is a multiview 3D reconstruction method which allows a full 3D model reconstruction of a target scene starting only by a series of overlapping pictures of the target itself. 3D modeling starts with the acquisition of images (Figure 17) considering that for the characterization of the surface roughness any point in the images must be present in at least 3 photographs, preferably more. As such, when taking photos, ensure considerable overlap between images. Any type of camera should acquire images suitable for 3D reconstruction, during the field campaign we have used a Canon EOS 450D, collecting from a minimum of 100 to a maximum of 400 photos per model The 3D reconstructions from the sequences of photos have been obtained by using VisualSFM (free sw developed at Washington University), an environment that offers a graphical interface for running the complex sequence of algorithms that defines the Sfm technique itself. In VisualSFM three main steps of the Sfm reconstructions are provided by the following applications (Figure 17):

- SiftGPU, a version implemented on GPU SIFT (Scale Invariant Feature Transform), a "pattern recognition" software used to find corresponding features in different images;
- PBA (or ParallelPBA): "parallel bundle adjustment" software implementation for a multicore CPU and GPU. Once the corresponding key points have been identified across a series of images by the SIFT algorithm, the change in key-point position in different images is considered in the Sfm process to clump the position of such points in a 3D reference system. This complex process takes also into account the focal length and sensor width of the camera. The output provides camera parameters and positions for each considered input image using a optimization technique called "bundle adjustment". This stage also outputs a sparse cloud of 3D points representing the imaged scene (Figure 17a).
- PMVS/CMVS: a sequence of software (the Patch-based Multi-View Stereo package; http://grail.cs.washington.edu/software/pmvs/) used to obtain a 3D densified point cloud starting from the output of the PBA stage and which provides a very detailed and realistic model of the imaged scene (Figure 17c-e).

Site	Model name	Date-hour yyyy-mm-dd hh:mm	Number of photo
Ougarta 1	1	2014-05-08 - 7:15	392
Ougarta 2	2	2014-05-08 - 9:56	240
Ougarta 3	3a	2014-05-08 - 16:05	217
Ougarta 3	3b	2014-05-08 - 16:25	279
Ougarta 3	3c	2014-05-08 - 16:40	210
Ougarta 4	4	2014-05-08 - 17:08	314
Ougarta 5	5a	2014-05-09 - 8:17	367
Ougarta 5	5b	2014-05-09 - 8:44	296
Ougarta 6	6a	2014-05-09 - 16:49	371
Ougarta 6	6b	2014-05-09 - 17:03	122
Ougarta 7	7	2014-05-10 - 8:25	399

Table 4. Acquisition day and time of the sampled sites. Each site has been sensed with the number of photo reported in the last column.

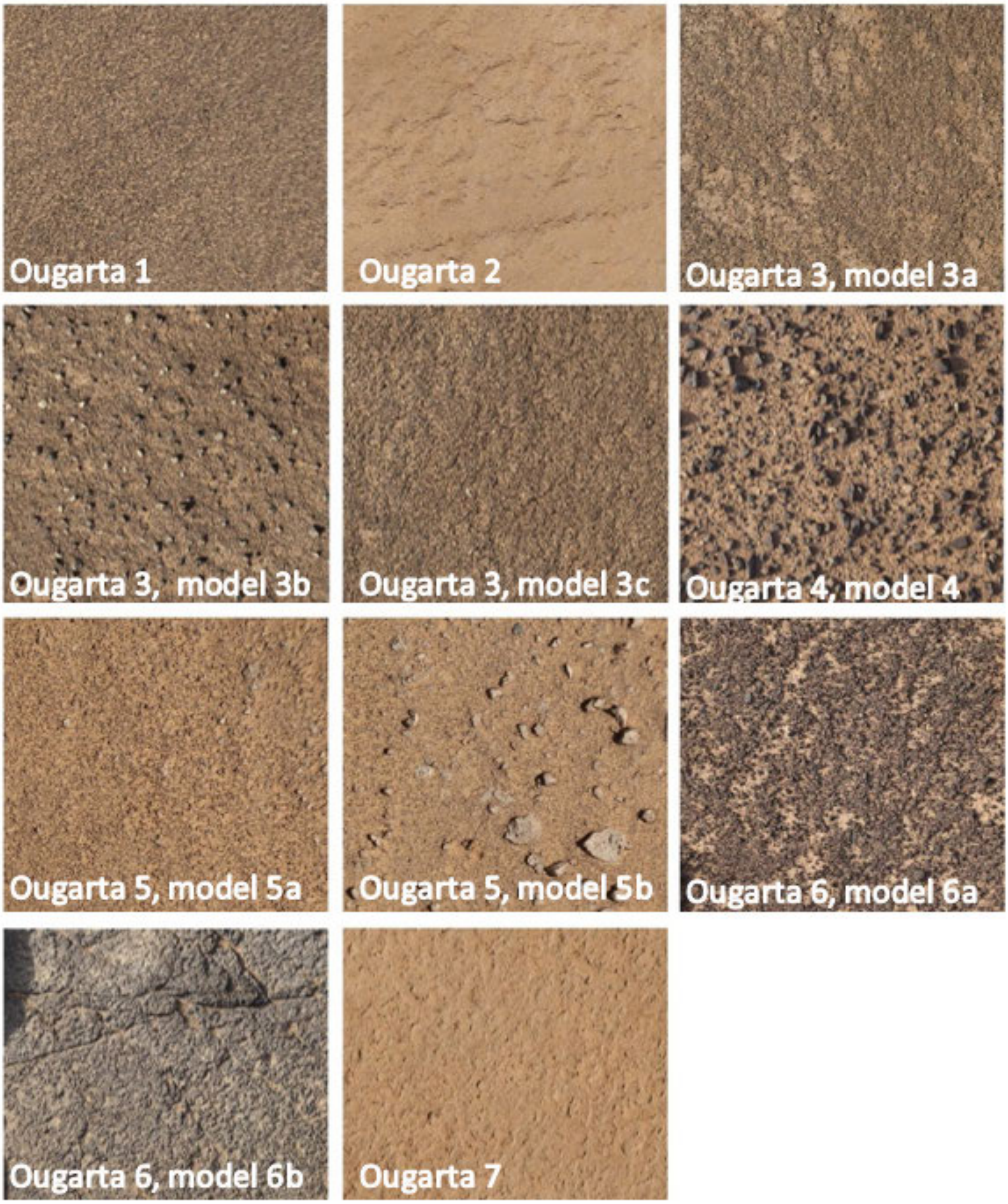

Figure 16. Generated model and points distribution.

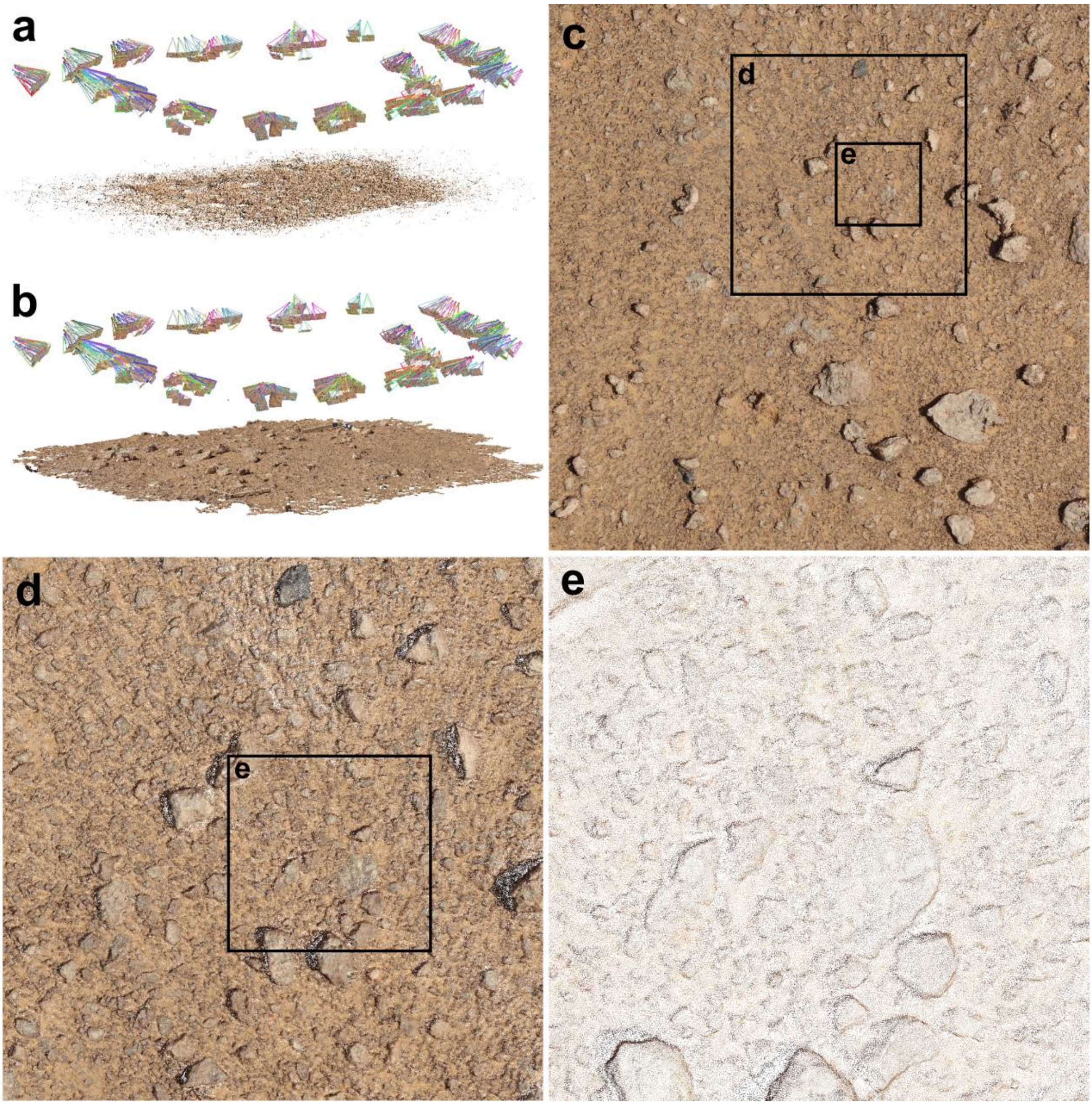

Figure 17. Example of 3D model (site Ougarta 5, model 5b). a) Simplified model obtained by the software PBA. b) Model obtained by PMVS / CMVS. c), d) and e) cloud model 5b (site Ougarta 5) at various magnifications.

Conclusions

In this work, the results of the preliminary activities for the identification and characterization of a vicarious CAL/VAL site on Western Sahara have been reported.

During the dedicated field campaign several measurements have been performed aimed to the surface characterization (by acquiring surface spectra, surface temperature and 3 D surface modelling) and atmosphere definition (by atmosphere optical thickness measures). Moreover surface geology information have been collected to complete the requirements analysis necessary for the CAL/VAL site proposition.

By analyzing all the data acquired Ougarta 2, 5 and 7 areas seem to be compliant to the LES class attribution and suitable for a further characterization (Table 5).

Besides geophysical and geological results also the easy access to Ougarta 7 area and the capability to set up instrumentally the area permanently make this site appropriate for the definition of CAL/VAL area suitable for both the next ASI-PRISMA mission and future space missions.

Questionnaire Content Description	LES	LNSE	Ougarta Compliance
Site location	x	x	x
Logistic information	x		x
Site climatology	x	x	x
Calibration methodology		x	NA
Site instrumentation	x		x
Measurement accuracy	x		x
Site usage	x	x	x
Sampling strategy		x	x
Contact information	x	x	NA
Data availability	x	x	NA

Table 5. Compliance matrix among the CEOS requirements and the Ougarta characteristics.

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