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IT applications for sharing geoheritage information: the example of the geological and geomorphological trail in the Monviso massif (NW Italy)

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ABSTRACT

Collection and sharing of geoheritage information are nowadays enhanced by using digital tools and IT (Information Technology) applications that allow homogeneous storing of data, building of sharable databases, and transfer of knowledge between experts and communities. In the frame of the PROGEO-Piemonte project (PROactive management of GEOlogical heritage in the PIEMONTE region), the geological and geomorphological trail in the Monviso Massif (Western Alps) is an example of how IT-applications may support management of geoheritage information. The trail particularly allows to walk across the meta-ophiolite succession of an ancient ocean and on glacial landforms. Its realization was supported by different tools that allow (*i*) capturing of data via GPS handheld mobile device, (*ii*) managing of field data by means of GIS (Geographic Information Systems) applications, and (*iii*) virtual visualization of data by means of GIS-based 3D viewer. The different (virtual) views of the geology along the trail can be implemented by adding photos and bookmarks and easily shared through web mapping tools that ensure wide accessibility of geoheritage information.

KEY WORDS: geoheritage, Geographic Information Systems, Monviso Meta-ophiolite Complex, glacial landforms.

INTRODUCTION

Geoheritage information comes from areas that, for their peculiar features and/or unique characteristics, are of geological interest (i.e. geosites). An important activity for management of geosites consists of developing useful tools for homogeneously collecting data and widely sharing information (Cayla, 2014). IT applications help to meet these needs and support different activities such as accurate storing of data, realization of sharable databases, and transfer of knowledge between experts and communities (Balestro et al., 2013a).

An example of how IT applications may enhance management and sharing of geoheritage information corresponds to the geological and geomorphological trail realized in the Monviso massif (Rolfo et al., 2014a). The trail is part of the PROGEO-Piemonte (PROactive management of GEOlogical heritage in the PIEMONTE region) project that aims to inventory geosites in the Piemonte region (NW Italy) and to promote both their conservation and divulgation. Within the project, nine geothematic areas have been chosen, each one being characterized by high potential for scientific studies, enhancement of public understanding of science, and also economic support to local communities (Giardino et al., 2012).

One of these ProGEO geothematic areas corresponds to the Monviso massif. The latter was lately recognized as a Biosphere Reserve (MAB Programme of UNESCO), and, because of its spectacular geology and mountain landscapes, is considered a symbol of the Italian Western Alps (Rolfo et al., 2014b).

THE GEOLOGICAL AND GEOMORPHOLOGICAL TRAIL IN THE MONVISO MASSIF

The geological and geomorphological trail in the Monviso Massif particularly allows to walk *i*) across the meta-ophiolite succession of an ancient ocean (i.e. the Monviso Meta-ophiolite Complex; Lombardo et al., 1978; Balestro et al., 2014a; Balestro et al., 2014b; Castelli et al., 2014) and *ii*) on the glacial landforms related both to the Last Glacial Maximum and to the Little Ice Age (Balestro et al., 2011; Balestro et al., 2013b).

The Monviso Meta-ophiolite Complex is an important remnant of the Mesozoic Tethyan oceanic lithosphere that was dragged at depth during subduction, and stacked in the axial sector of the Western Alps during collision-related exhumation. During Alpine tectonic, original ophiolite sequences (i.e. serpentinized peridotite, gabbros, basalt and sediments), were dismembered into different tectonic units that characterize the inner architecture of the Monviso Meta-Ophiolite Complex.

The present-day morphology of the Monviso massif results

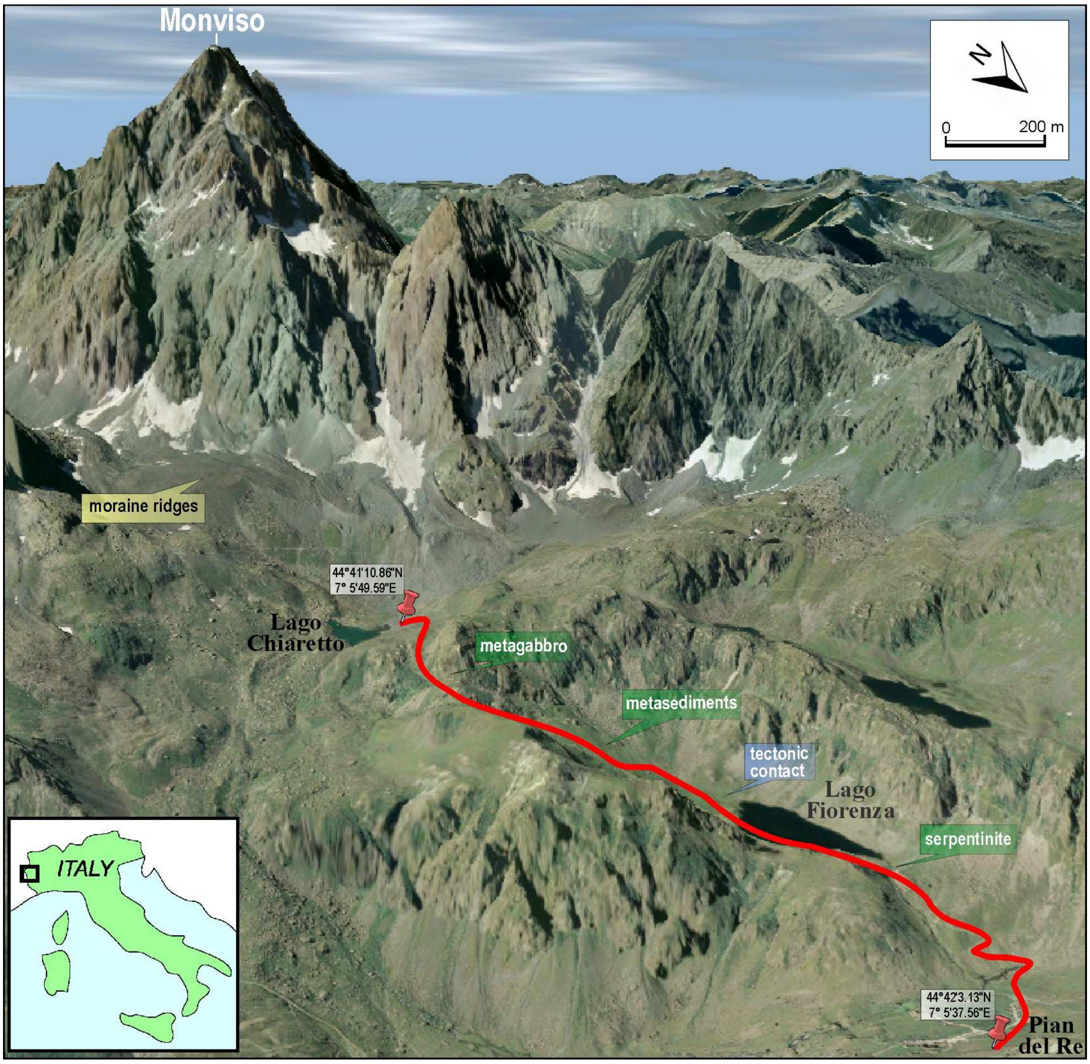

Fig. 1 – Virtual view of the geological and geomorphological trail (red line) in the Monviso massif.

from the interaction between the lithostructural features of the bedrock and glacial erosion active during the Pleistocene glaciations. Glacial deposits related to the Last Glacial Maximum and to the subsequent glacier retreat are in particular extensively preserved at the head of the Po Valley.

From the Po river springs at the Pian del Re locality (about 2000 m a.s.l.), to Lago Fiorenza, Colletto Fiorenza and Lago Chiaretto (about 2250 m a.s.l.), different lithological, structural and geomorphological features are shown (Fig. 1).

Between Pian del Re and Lago Fiorenza, the path reaches an outcrop of original mantle rocks (now serpentinite) that include meter-sized bodies of eclogitic Fe-Ti metagabbro. The tectonic contact that separates these rocks from the overlying smaragdite-bearing metagabbro (Fig. 2a), is well-exposed at Lago Fiorenza and at Colletto Fiorenza, and consists of sheared serpentinite and of metasediments (calcschist, marble and quartzite) that originally deposited on ocean floor. Lago Fiorenza is particularly localized in a valley where glacial modeling is strongly constrained by occurrence of the weak rocks that characterize the tectonic contact.

Between Colletto Fiorenza e Lago Chiaretto, the trial passes through smaragdite-bearing metagabbro and, at Lago Chiaretto, a wonderful view on the NE slope of the Monviso (i.e. the peak of the Monviso massif, 3841 m a.s.l.) is exposed. The slope mainly consists of metabasalt, that is the more abundant rock in the upper part of the Monviso Meta-Ophiolite Complex. The foot of the slope is characterized by well-preserved moraine ridges that formed during the Little Ice Age. The boundary between these glacial deposits and the deposits of the Last Glacial Maximum (Fig. 2b), is well-exposed SW of Lago Chiaretto.

IT APPLICATIONS

The applications of IT tools in the realization of the geological trail consisted of three main steps.

The first step consisted of via GPS capturing of data in the field. Digital geological mapping was performed by means of a GIS mobile software loaded on a rugged handheld device. Lithological, structural and geomorphological features with their attributes were stored in different layers that form the field database.

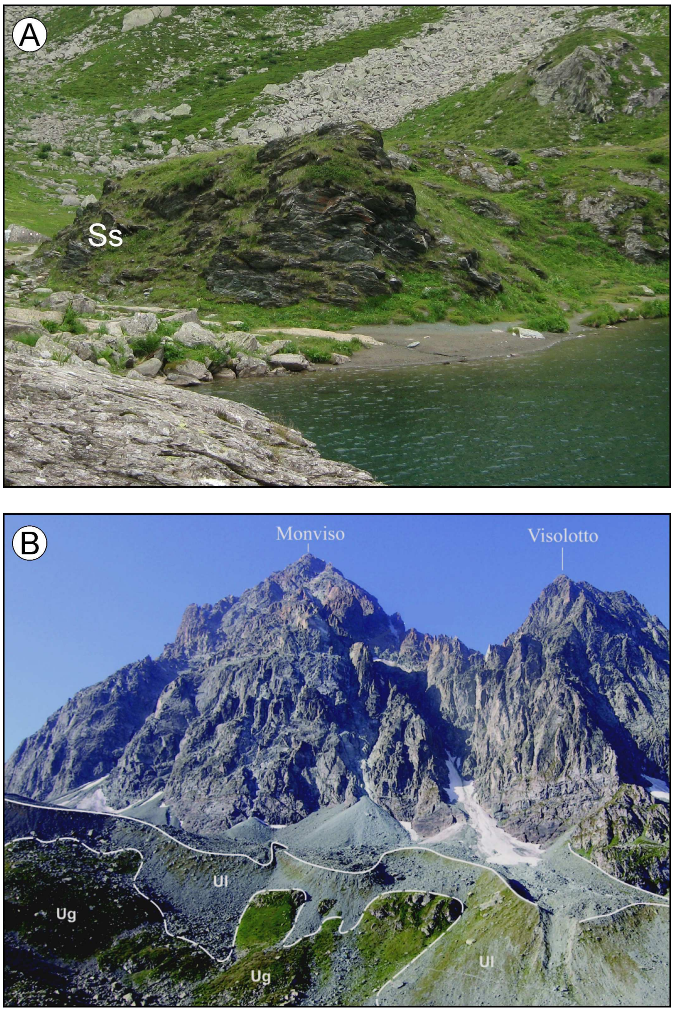

Fig. 2 – (A) Sheared serpentinite (Ss) characterizing the tectonic contact exposed at Lago Fiorenza; (B) Geomorphological landscape at the foot of the NE Monviso slope: the white lines highlight the moraine ridge of the Little Ice Age glaciers; the dashed line separates the Little Ice Age glacial deposits (Ul) from the Last Glacial Maximum deposits (Ug) (modified from Balestro et al., 2013b).

The second step in storing geoheritage information corresponded to the realization of a geological map database. The latter consists of the following main layers:

- "*monvisopoligoni*", wherein outcrops from field database were interpreted and different lithologies were represented;
- "*limiti*", that directly overlays the "monvisopoligoni" layer and contains both stratigraphic and tectonic boundaries;
- "*monvisomisure*", wherein foliations and fold axis/axial planes measured in the field were generalized;
- "*geomorfologia*", that contains different alluvial, glacial and gravitational landforms.

In the third step, meaningful lithological, geomorphological and structural features derived from the geological map database were processed and represented by means of 3D landscape visualizations.

Virtual visualizations were built through a GIS-based 3D-viewer, loading the DTM (resolution of 5 meters) and the aerial images (2010, Regione Piemonte) that are managed by the Arpa Piemonte Geoportal (*http://webgis.arpa.piemonte.it/risknat/*).

Virtual visualizations of geoheritage information were focused on

- positioning along the trail of outcrop images that show the characteristics of the different lithologies,

- draping of meaningful geomorphological features such as moraine ridges and the boundary between different glacial deposits (related to the Last Glacial Maximum and to the Little Ice Age, respectively),

- draping the tectonic contacts that separate the different units of the Monviso Meta-ophiolite Complex, and projecting representative planes according to their attitude (Fig. 3).

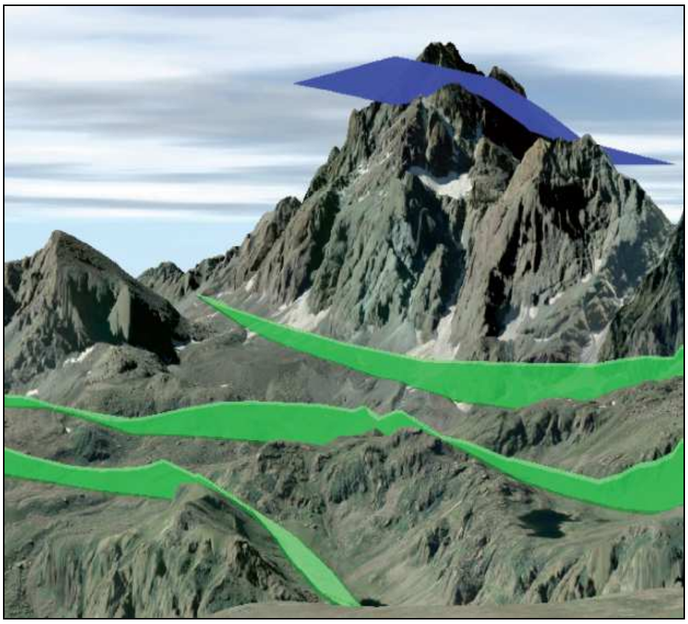

Fig. 3 – 3D visualization of the tectonic contacts (green and blue planes) that characterize the inner structure of the Monviso Meta-ophiolite Complex.

CONCLUSIONS

Sharing and spreading of geoheritage information are nowadays widely enhanced by use of IT applications.

Digital geological mapping and GIS databases ensure homogeneous data collection and organization of information, whereas landscape visualizations give realistic and easy-to-read representations of areas of geological interest.

Landscape visualizations can be implemented by adding sketches and bookmarks along the geological and geomorphological trail, and can be easily shared through web mapping tools that ensure wide accessibility of geoheritage information.

3D virtual visualizations are also a useful tool to overcome the problems that commonly occur in transferring contents of geological maps to non-expert users.

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