ISTITUTO NAZIONALE DI GEOFISICA E VULCANOLOGIA

Geological report at the seismic station IT.SULP – Sulmona (AQ)

Report geologico per il sito della stazione sismica IT.SULP – Sulmona (AQ)

Working Group: **Luca MINARELLI** **Irene DI GIORGIO**	Date: Dicembre 2019
Subject: **Final report illustrating the geological setting for station IT.SULP**	

Convenzione DPC-INGV 2019-21, All.B2- WP1, Task 2: "Caratterizzazione siti accelerometrici" (Coord.: G.Cultrera, F. Pacor)
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1. INTRODUCTION

The geological description is related to the site of studied seismic station. The coordinates are reported in Table 1.

Table 1.

CODE	NAME	LAT [°]	LON [°]	ELEVATION [m]
IT.SULP	Sulmona Polizia (Sulmona)	42.08500*	13.92740*	405
ADDRESS	Via Fonte D'Amore, 1, 67039 Sulmona AQ, Italy			

* Coordinates from ITACA (Dec. 2019)

2. TOPOGRAPHIC AND GEOLOGICAL INFORMATION

Topographic information related to the site are reported in Table 2. Table 3 summarizes all available geological maps from literature for geological analyses.

Table 2.

Topography	Description	Topography Class	Morphology Class	EC8 Class
	Flat surfaces, isolated slope and reliefs with slope i<=15°	T1	VE*	C

*According to nomenclature of ITACA (Dec. 2019)

Table 3.

Geological map	Source	Scale
IT.SULP	Geological map of Italy sheet *N.146* (Sulmona)	1:100.000
IT.SULP	Geological map of Italy sheet *N.369* (Sulmona)	1:50.000
IT.SULP	Geological and technical map – Seismic Microzonation	1:5.000

In Table 4 Geological, Lithological and Lithotechnical Units (according to Seismic Microzonation classification; Technical Commission MS, 2015) are described and are concerned to maps of following chapters. The term "original" means the result comes from a preexisting cartography (Table 3); the term "deduced" means the result comes from an interpretation of a preexisting cartography according to the nomenclature of corresponding cartography.

Table 4

GEOLOGICAL UNITS		**LITHOTECHNICAL UNIT**	
(5k Geological map of seismic microzonation - Municipality of Sulmona). *Original.*		(MZS). According to the nomenclature of Seismic Microzonation (Technical Commission MS, 2015). *Deduced.*	
code	**description**	**code**	**description**
col	Eluvial-colluvial cover	Mlec	Inorganic silt, silty or clayey fine sand, low-plasticity clayey silt
at3	Alluvial terrace- third order	SWtf	Well sorted sand, gravelly sand
at2	Alluvial terrace- second order		
fal-b	Debris-flow	GWfd	Well sorted gravel, mixed gravel an d sand
fal-a	Ancient debris-flow	GRSfd	Stratified cemented, stratified

3. GEOLOGICAL MAP

In Figure 1 Geological Map is reported in a 1kmx1Km square around the station.

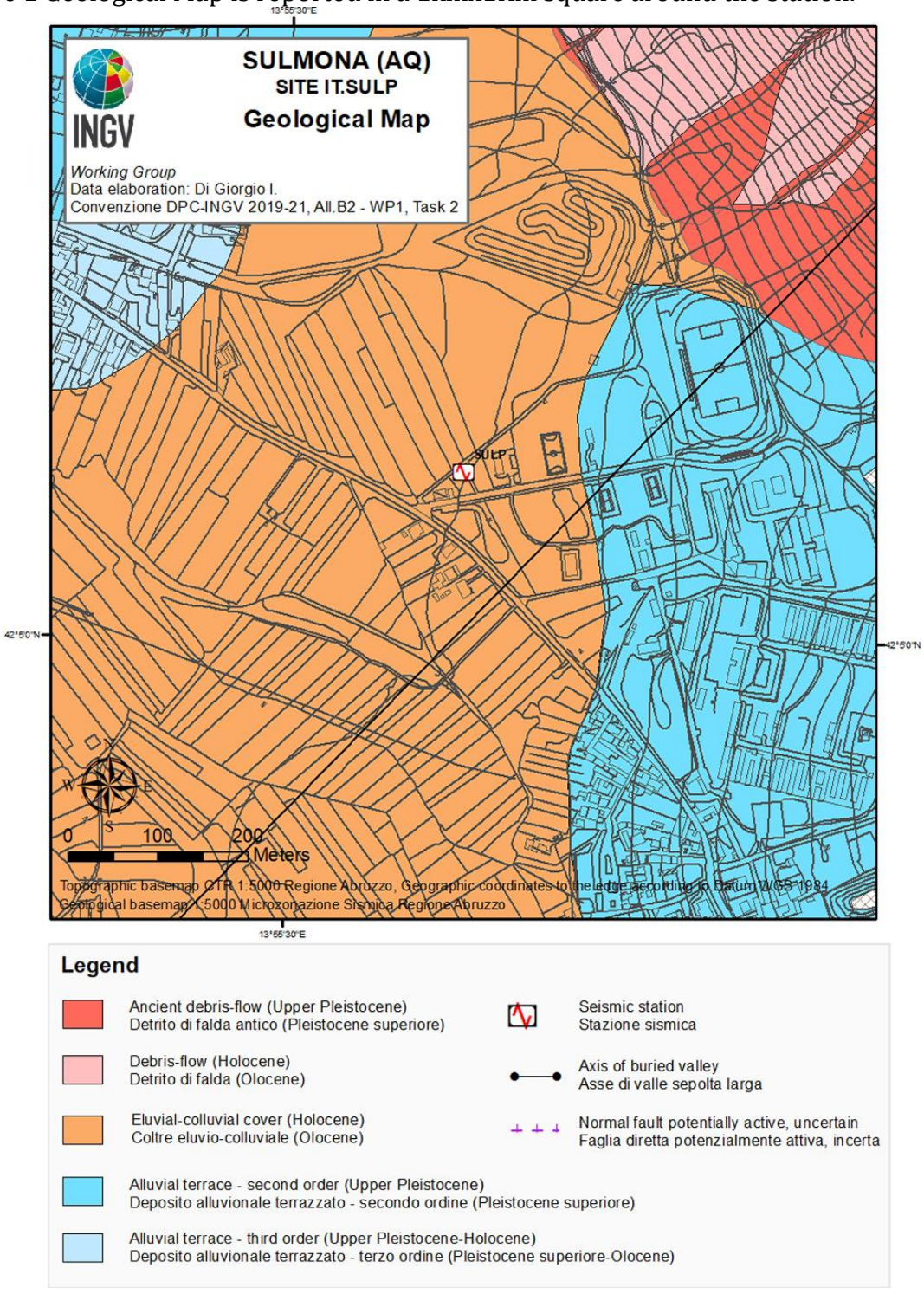

Figure 1. Geological map of seismic station IT.SULP. Scale 1:5.000. Geological units are established according to the nomenclature of geological map of seismic microzonation - Municipality of Sulmona.

4. LITHOTECHNICAL MAP

In Figure 2 Lithotechnical Map is reported in a 1kmx1Km square around the station.

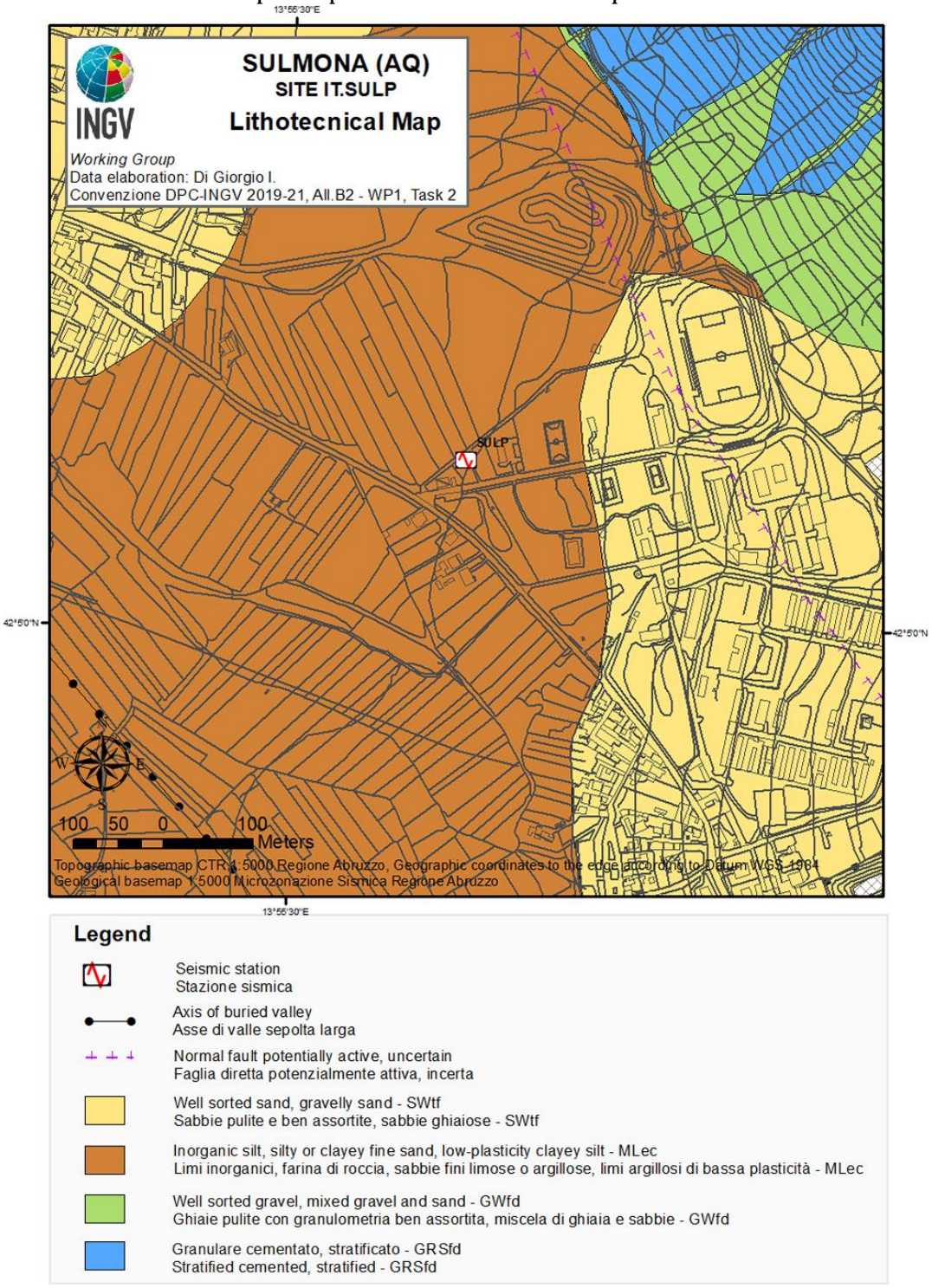

Figure 2: Lithotechnical map of the seismic station IT.SULP. Scale 1:5.000. The lithotechnical units are assigned according to the nomenclature of Seismic Microzonation (Technical Commission MS, 2015).

5. SURVEY MAP

Figure 3 shows the survey Map reported both previous investigations and geophysics surveys conducted by INGV Working Group.

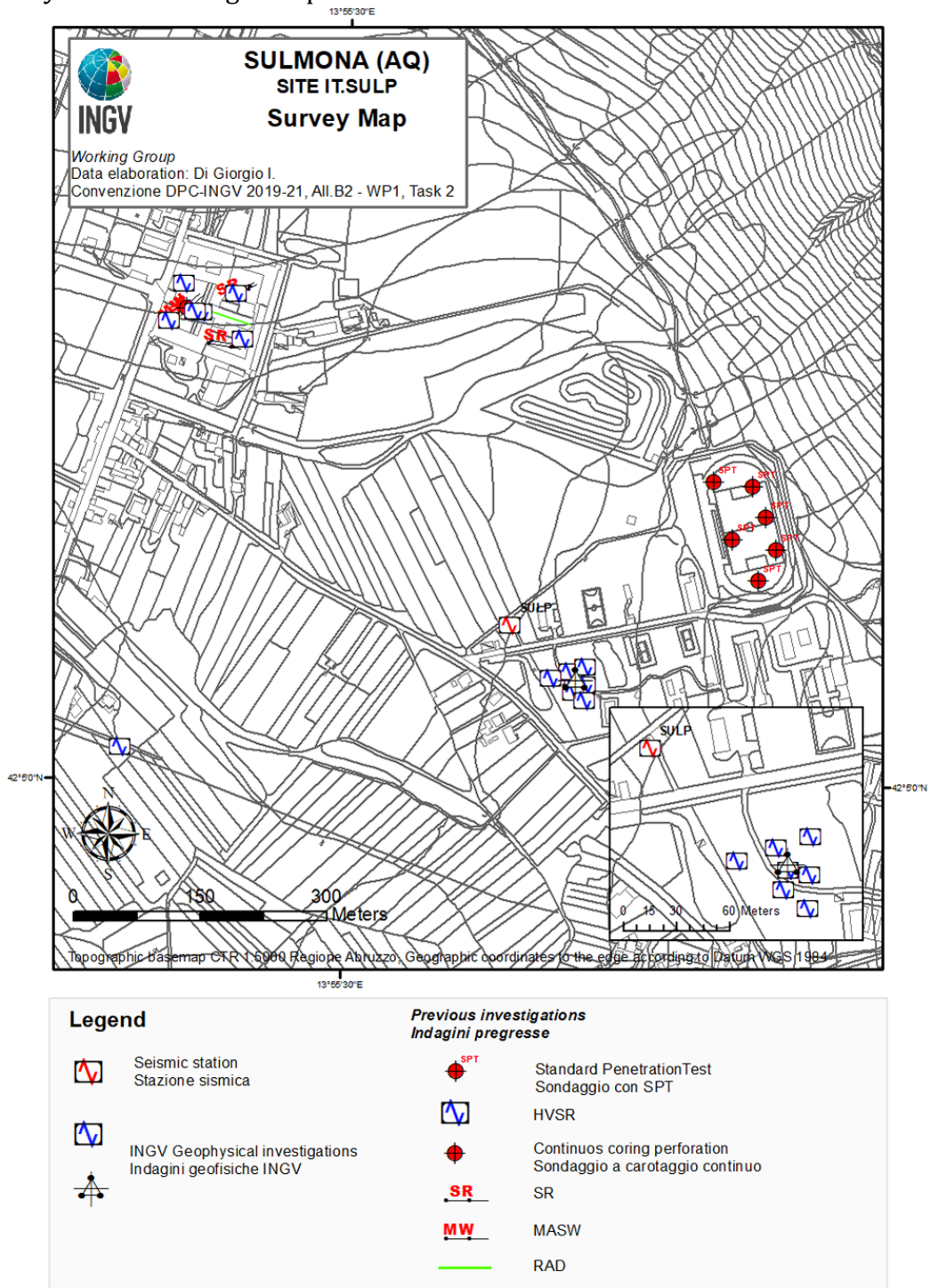

Figure 3: Map of the surveys in the surroundings of the station IV.FERS. Scala 1: 5.000. The box at the bottom right contains a zoom of the area with the detail of the geophysical investigation conducted by INGV Working Group for the seismic characterization of the site (Convenzione DPC-INGV 2019-21, Allegato B2-WP1, Task B, Velocity profile at the seismic station report IT.SULP).

6. GEOLOGICAL MODEL

6.1 General description

The seismic station is located in the Sulmona Basin, an intramontane basin extended in a NW-SE direction, in the outermost portion of the Central Apennines of Abruzzo. The compressive tectonic stress that led to the formation of the Apennine Chain generated a system of overthrusts and folds with north-eastern vergence. The tectonic structures here essentially involve the Triassic-Miocene carbonate cover, belonging to the Lazio-Abruzzo domain. In the examined area, the platform and basin carbonates outcrop in the large anticline structure of the Monte Morrone. The carbonate successions constitute the oldest outcropping units of the geological substratum, here thrusting toward the north-east, over the more recent Tertiary terrigenous units of the Apennine Foredeep (Figure 4). The Sulmona Basin was developed by Plio-Pleistocene distensive deformation, on the inner side of the Morrone fold, affected by a system of normal NO-SE striking faults. These normal faults are linked to the intense extentional phase that has affected the area since the beginning of the Pleistocene. These faults, associated with the individual seismogenic sources ITIS040 "Sulmona Basin" (DISS Working Group, 2018), are responsible for the frequent seismicity affecting this axial sector of the Apennine chain (e.g., Calamita et al., 1994; Galadini e Galli, 2000; Pizzi e Galadini, 2009). The tectonic activity of these faults induced the development of a halfgraben and of a strongly asymmetric basin, with the depocenter placed in the eastern sectors, near the Morrone border-fault system.

The Sulmona halfgraben is filled by a thick Pleistocene-Holocene succession, consisting of continental clastic deposits, several hundred meters thick, deposited into lake, river and slope environments. The seismic station is placed on these continental successions.

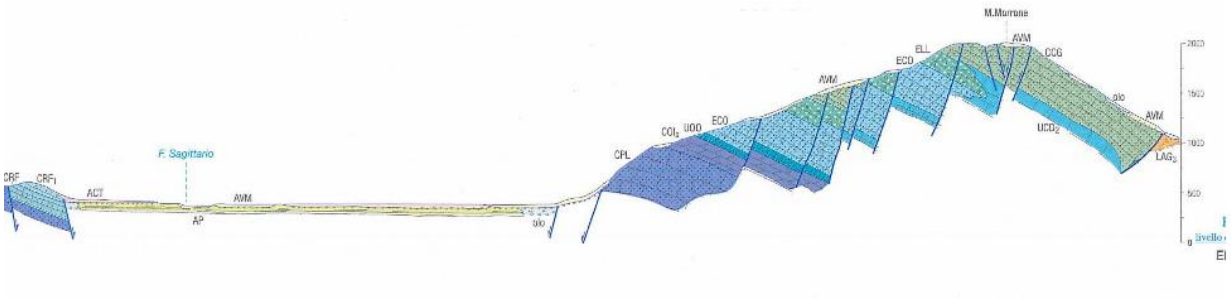

Figure 4: Structural profile crossing the Monte Morrone and the Sulmona Basin Plain. The folded Mesozoic carbonate units overthrusted Tertiary tubidites and were then dissected by a system of Plio-Pleistocene normal faults (Sheet 369 - 1:50.000 "Sulmona").

6.2 Geological Section

The seismic station is located in Fonte d'Amore, at the foot of Monte Morrone, near the border faults delimiting the eastern edge of the Sulmona Basin. The geological section C-C '(Figure. 5), attached to the seismic microzonation of the Municipality of Sulmona, describes the geological and structural structure of the study area. The section, traced just a few tens of meters from the seismic station, is based on the stratigraphic correlation at the basin scale, based on information from geological field surveys and geotechnical and geophysical surveys of the subsoil.

Upstream of the study area, the imposing carbonate successions of the Monte Morrone belongs to the geological substratum outcrop. Close to the walls of the Morrone, there are thick layers of breccias and conglomerates of cemented debris, which cover the geological substrate by the direct fault. At the In the basin margin, the slope deposit interfinger with sandy-gravelly river deposits, with a total thickness of several tens of meters, forming terraces and alluvial fans. The fluvial units rest on peaty clay deposits of very variable thickness, deposited into lake environment. The lake successions show a maximum thickness of several hundred meters, in the depocentral areas of the eastern sectors of the basin. The thicknesses decrease sharply proceeding towards the northern and western edges of the Sulmona valley. The lake deposits present intercalations of gravelly-sandy fluvio-deltaic bodies, which become more frequent and thick near the edges of the basin.

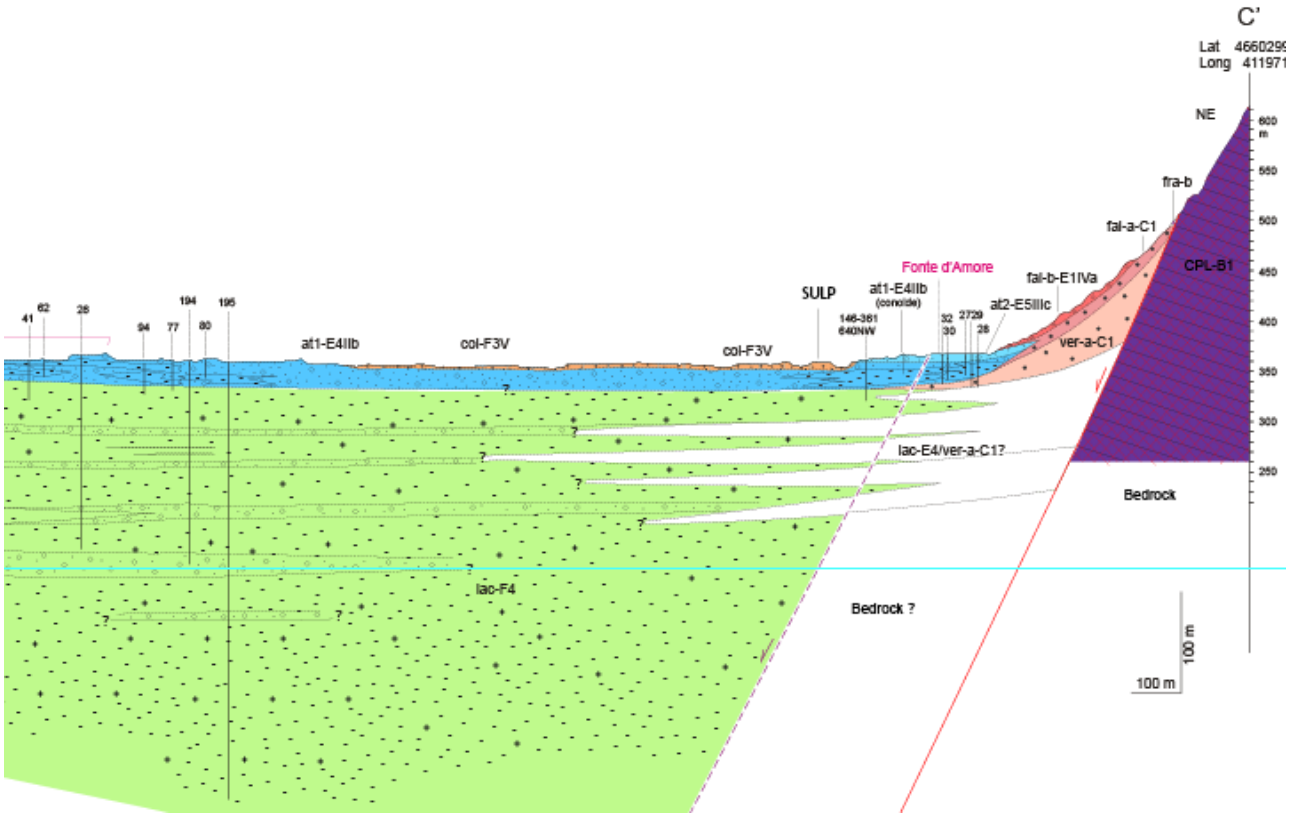

Figure 5: Schematic geological cross section showing the relationships between the Mesozoic carbonate bedrocks and the Quaternary sedimentary infilling of the active graben basin (Sulmona Seismic Microzonation - geological cross section C-C').

6.3 Subsoil model

A model to the depth of 100 m was developed for the area surrounding the IT.SULP station (Figure 6). The model is based on the extrapolation of surface data, existing geotechnical and geophysical surveys, and new geophysical investigations, performed by the INGV Working Group, for the seismic characterization of the site and the definition of the velocities profiles of the body waves. The subsoil model is well constrained in the for the first 30 - 40 m of subsurface, thanks to the correlation of continuous coring probes, available near the seismic station and, downstream, in the Sulmona Basin. The first meters of subsurface consist of clayey and sandy silts (brown in Figure 1 and Figure 5), related to colluvial layers. The eluvial-colluvial interval rests on silty-sandy deposits of the distal alluvial fan, interfingering with coarser bodies of sands and rare river gravels (blue in Figure 1 and Figure 5). The alluvial

deposits have a total thickness of about 30 m. As visible from the geological section C-C ', the lower portion of the subsurface model is here suggested with a high degree of uncertainty, due to the lack of stratigraphic investigation crossing the deepest portion of the basin sedimentary succession. Beneath the terraced alluvial deposits, there are silty-peaty clays, deposited into a lake environment. In basin margin areas, such as the one in question, the cohesive lake sediments intertwine downwards with ancient slope breccias and cemented conglomerates that become generally more abundant in the lower portion (see Figure 5). These ancient well cemented slope deposits can reach a very high stiffness, comparable to that of a seismic bedrock and of the Mesozoic substrate. In these border areas, the geological substratum, consisting of Triassic-Miocene carbonate units, has not been precisely located at depth.

The seismic velocity profiles obtained from geophysical investigations performed for the characterization of the site (Convenzione DPC-INGV 2019-21, Allegato B2-WP1, Task B http://hdl.handle.net/2122/12969) suggest deposits with low Vs values down to a depth of about 100 meters. The values of Vs around 1200 m/s, given to the seismic bedrock, seem more compatible with those of cemented granular deposits than with those of strong Mesozoic carbonatic successions. The geophysical data are in agreement with the proposed subsoil model.

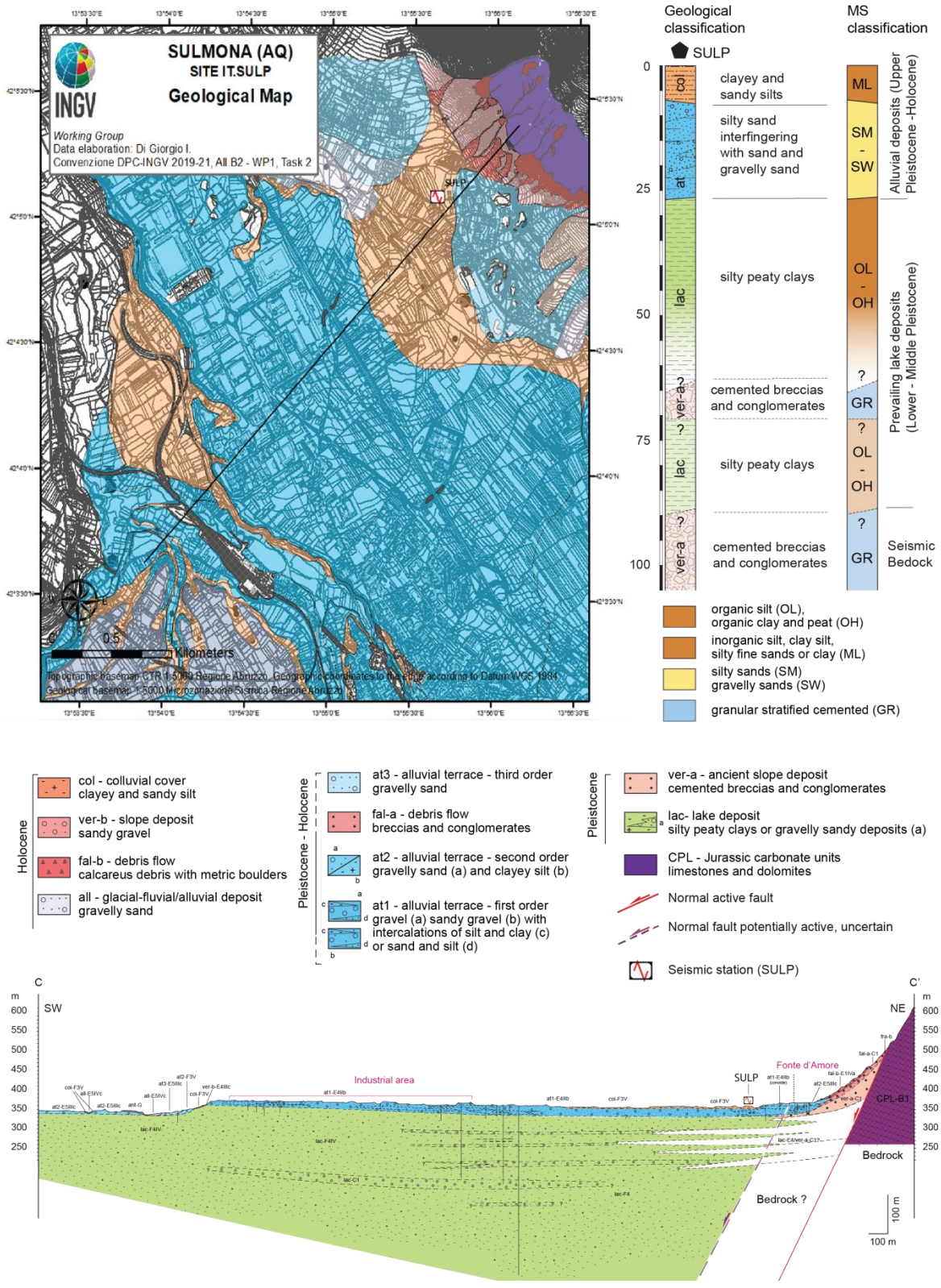

Figure 6: Bottom - Geological section C-C' crossing seismic station IT.SULP. Right - Subsoil model under the IT.SULP seismic station and classification according nomenclature of geological map of Italy 1:50.000 and according to Seismic Microzonation (MS).

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