Geological Field Trips and Maps, Vol. 15(1.1) (2023) (https://doi.org/10.3301/GFT.2023.01)
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UAV-BASED HIGH RESOLUTION MAPPING OF A COMPLEX LANDSLIDE: AN EXAMPLE FROM BASILICATA, SOUTHERN ITALY

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Scale 1:1,000

LEGEND

QUATERNARY UNITS

UCN_{a3} Alluvial deposit: gravel and sand of the present-day thalweg. (*HOLOCENE*)

UCN_a Colluvial deposit: brown sand with eterometric angular calcareous clast, locally anthropically reworked. (*HOLOCENE*)

Landslide deposits
Facies descriptions: structureless reddish gravelly silty clay with carbonate angular clasts ranging in size from 4 to 50 cm (debris flow deposits: facies x1); structureless red, gray, and green clay with carbonate angular clasts and blocks ranging in size from 4 cm to 1-2 m (debris flow deposits: facies x2); laminated to massive grey-green clay (suspension fall-out from a mud flow: facies y); very deformed grey-green and red clay with isolated calcareous clasts (sediment slump: facies z)

UCN_{a1x} with clues of incipient activity (**UCN_{a1}**);
UCN_{a1z} landslide body consisting of several debris flow units which occurred from 1973 (Cotecchia et al, 1986; Bentivenga et al., 2019) to 2013 (**UCN_{a1a}**); landslide bodies occurred in 2014 (**UCN_{a1b}**); landslides bodies occurred in 2015 (**UCN_{a1c}**); landslides bodies occurred in 2016 (**UCN_{a1d}**); landslides bodies occured from 2017 to 2018 (**UCN_{a1e}**).
UCN_{a1b}
UCN_{a1a}

UCN_{a2b} Ancient deposits related to debris fans reaching the current thalweg of the Basento River.
UCN_{a2a}

UCN_{a3} Ancient deposits hung on the Basento River thalweg. (*UPPER PLEISTOCENE? - HOLOCENE*)

UNITS OF THE SEDIMENTARY BEDROCK

FYR **FLYSCH ROSSO**
Alternate beds (5-30 cm thick) of red laminated marly clay and massive to graded calcarenite (turbidite deposits and pelagic sediments).
(*LOWER CRETACEOUS - OLIGOCENE p.p.*)
c: calcarenite-made olistolite

MECHANICAL CONTACT

CAM_4
CAM_3 **CAMPOMAGGIORE FORMATION**
CAM_2 Deformed beds of dark grey-green siliceous claystone with subordinate red beds of siliceous radiolarian mudstone and rare cm-beds of black organic-rich mudstone (black shales) and of fine-grained calcarenite and calciulite (**CAM_1**). Chaotic red siliceous radiolarian-rich claystone with fragment of fine-grained calcarenite and calciulite 10-40 cm thick layers (**CAM_2**). About 7 m-thick of red, grey and subordinately black and yellow clay in thin-laminated beds with thickness from 1 mm to 15-20 cm (**CAM_3**). Thin laminated siliceous claystone, grey-green and red in colour with rare intercalations of centimetric layers of fine-grained calcarenite and black shales (**CAM_4**).
CAM_1 (*UPPER VALANGINIAN - LOWER-MIDDLE ALBIAN;* Sabato et al., 2007)

TECTONIC CONTACT

FXM_2 **VAL MILETTA FORMATION**
Thin or medium thick alternation of silty clay with intercalation of laminated calciluite (0.10-1.50 m thick) and subordinate massive and laminated middle- to fine-grained turbiditic calcarenite (**FXM**$_1$): 2-3 cm to 10-15 cm alternating beds of medium to coarse-grained sandstone and silty clay (**FXM_2**).
FXM_1 (*BURDIGALIAN p.p. - LANGHIAN p.p.*; Giannandrea et al., 2016)

TECTONIC CONTACT

AV **GRUPPO DELLE ARGILLE VARIEGATE**
Red, green, and grey shale with intercalation of calciluite and calcarenite, with a broken formation setting. (*EOCENE - OLIGOCENE*)

Outcrops of the bedrock sedimentary units

This research has been supported by MIUR PON R&I 2014-2020 Program (project MITIGO ARS01_00964).

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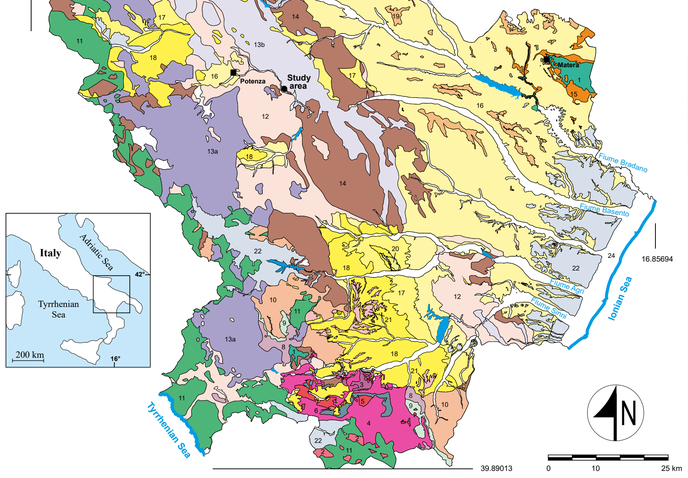
GEOLOGICAL SCHEME OF BASILICATA



LEGEND

24	Littoral, alluvial, and lacustrine units (*Upper Pleistocene - Olocene*)
23	Pyroclastic and sedimentary units of the Monte Vulture volcano and the associated alluvial-lacustrine basins (*Middle-Upper Pleistocene*)
22	Terraced alluvial and marine units (*Middle-Upper Pleistocene*)

PLIO-PLEISTOCENE UNITS OF THE APENNINE CHAIN AND BRADANO THROUGH

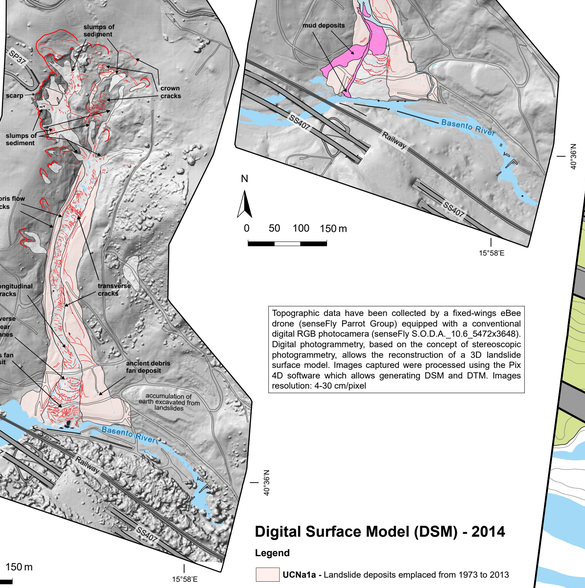
21	Sands and conglomerate
20	Lacustrine silty-sandy clay
19	Conglomerate with sandy intercalations
18	Conglomerate, sand, and clay
17	Sand and clay in alternate beds
16	Clay with sandy intercalations
15	Calcarenite

Lake

APENNINE CHAIN BEDROCK UNITS

14	**Irpinian Units** (*Lower - Upper Miocene*)
13a 13b	**Lagonegrese Units** 13a) (*Triassic - Oligocene*) 13b) (*Cretaceous - Oligocene*)
12	**Sicilide Units** (*Cretaceous - Lower Miocene*)
11	**Apennine platform Units** (*Triassic - Lower Miocene*)
	Liguride Units Sedimentary Units
10	Albidona Formation (*Upper Oligocene - Lower Miocene*)
9	Saraceno Formation (*Eocene p.p. - Oligocene p.p.*)
8	Crete Nere Formation (*Cretaceous - Eocene p.p.*)
	Metamorphic-crystalline Units
7	Metalimestone
6	Metabasite
5	Serpentinite
4	Shale
3	Gneiss
2	Phyllite
1	**Apulian platform Units** (*Jurassic - Cretaceous*)

Landslide stratigraphic scheme



Digital Terrain Model (DTM) - 2018

Legend

UCNa1c, UCNa1d and **UCNa1e -** Landslide deposits emplaced from 2015 to 2018

UCNa1b - Landslide deposits emplaced in 2014

UCNa1a - Landslide deposits emplaced from 1973 to 2013

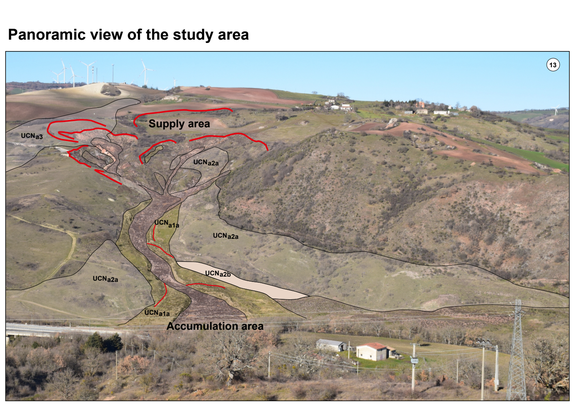
Topographic data have been collected by a fixed-wings eBee drone (senseFly Parrot Group) equipped with a conventional digital RGB photocamera (senseFly S.O.D.A._10.6_5472x3648). Digital photogrammetry, based on the concept of stereoscopic photogrammetry, allows the reconstruction of a 3D landslide surface model. Images captured were processed using the Pix 4D software which allows generating DSM and DTM. Images resolution: 4-30 cm/pixel

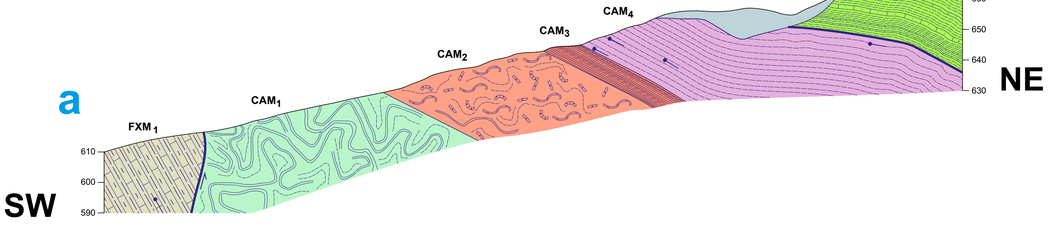
Digital Surface Model (DSM) - 2014

Legend

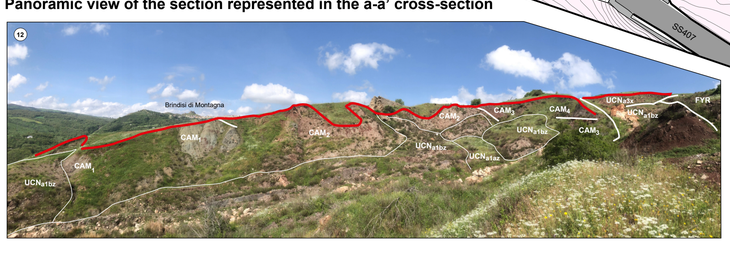
UCNa1a - Landslide deposits emplaced from 1973 to 2013

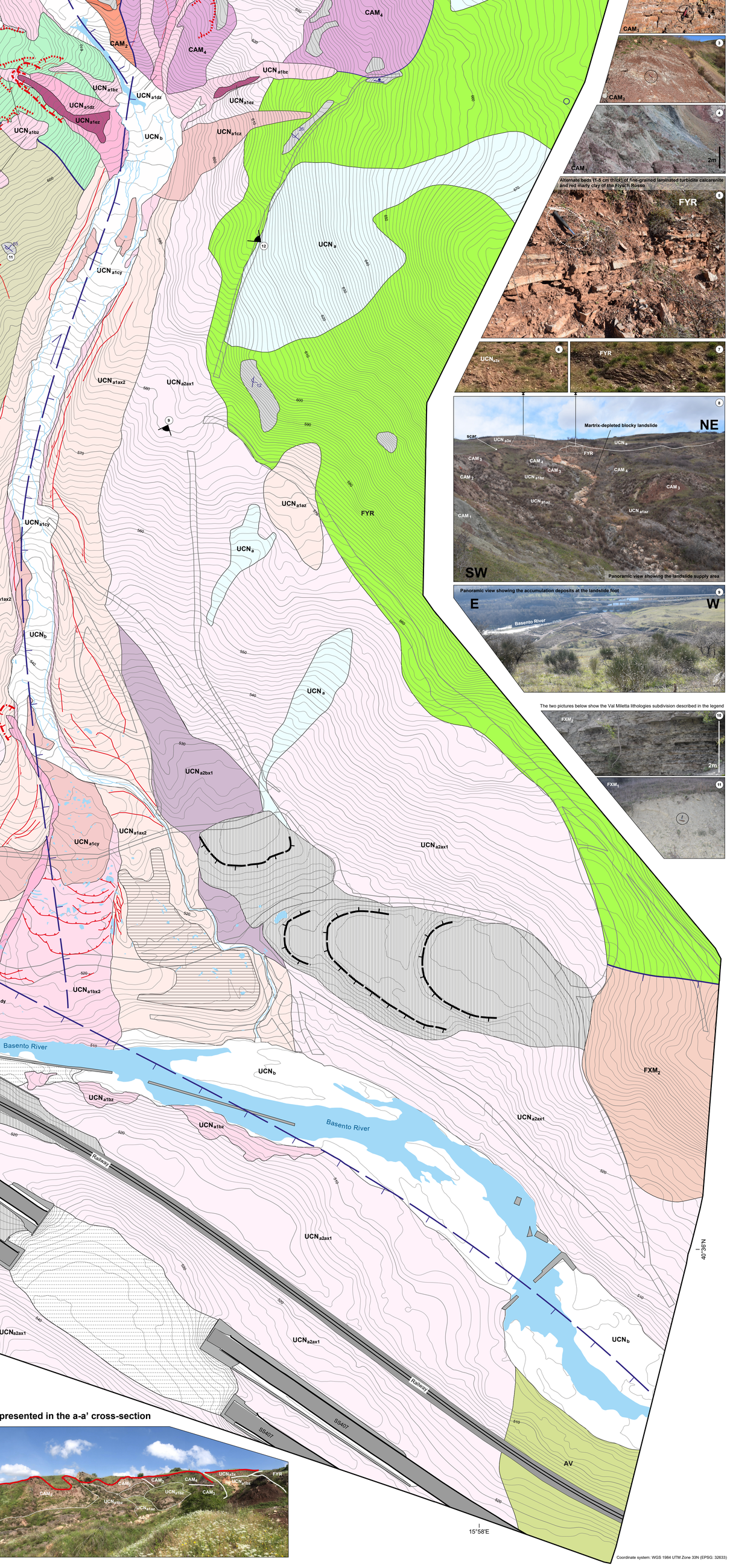
Panoramic view of the study area





Panoramic view of the section represented in the a-a' cross-section





Geomorphology

Scarp of the ridge created by earth accumulation
Rotational/translational slide primary scarp
Rotational/translational slide secondary scarp
lateral slip secondary scarp
Crown cracks
Longitudinal cracks
Gravity-induced reverse shear plane
Landslide scarp
Ancient
UCN_{a1a}
UCN_{a1b}
UCN_{a1d}
UCN_{a1e}
Ridge created for: motorway/railway and by accumulation of earth excavated from landslides
Matrix-depleted blocky landslide
Excavation surface
Embankment

Geological symbols

Stratigraphic boundary
Normal fault (dashed when uncertain)
Reverse fault (dashed when uncertain)
Strike-slip fault (dashed when uncertain)
15 Strike and dip
70 Overturned dip
Vertical dip (dot at the base)
Spring
a a' Geological cross-section
1 Point of photo depiction
Panoramic area

The four pictures below show the Campomaggiore formation lithofacies subdivision described in the legend

The two pictures below show the Val Miletta lithologies subdivision described in the legend

Coordinate system: WGS 1984 UTM Zone 33N (EPSG: 32633)