SOCIETÀ TOSCANA
DI
Scienze Naturali
RESIDENTE IN PISA

ATTI
DELLA
SOCIETÀ TOSCANA
DI
SCIENZE NATURALI

MEMORIE • SERIE A • VOLUME CXXVI • ANNO 2019

Edizioni ETS

INDICE - *CONTENTS*

Atti Soc. Tosc. Sci. Nat., Mem., Serie A, 126 (2019)
pagg. 67-74, figg. 9; tab. 1; *doi: 10.2424/ASTSN.M.2019.13*

DONATELLO MAGALDI [1]

INTERGLACIAL PLEISTOCENE PALEOSOLS SUPPORTING OLD ROADS IN CENTRAL TUSCANY

Abstract - D. MAGALDI, *Interglacial Pleistocene paleosols supporting old roads in central Tuscany.*
A survey conducted a few years ago highlights the relationships between the interglacial paleosols of thePleistocene and the old roads system from the Etruscan period to the end of the Middle Age in North- Central Tuscany. This note discusses geo-pedological data collected along the ancient roads and verifies, in light of recent paleopedological acquisitions in Europe and in the United States, the existence of correlation between the soil color classes and their resistance to penetration, highlighting the succession in time of at least three interglacial pedogenetic phases starting from the Middle Pleistocene until the beginning of the Holocene.

Key words - old roads, Pleistocene, soil redness, soil penetration resistance, Tuscany

Riassunto - D. MAGALDI, *Paleosuoli del Pleistocene interglaciale a supporto di antiche strade nella Toscana centrale.*
Una indagine di alcuni anni fa (Magaldi *et al*., 2017) mise in evidenza i rapporti intercorrenti tra gli antichi suoli del Pleistocene "caldo" e la viabilità antica dal periodo Etrusco alla fine del Medioevo, nella Toscana Centrosettentrionale. La presente nota elabora dati geo-pedologici raccolti lungo le antiche strade e alla luce di recenti acquisizioni di paleo-pedologia in Europa e negli Stati Uniti, verifica l'esistenza di un'ottima correlazione tra il colore del suolo e la sua resistenza alla penetrazione, che mette in evidenza la successione nel tempo di almeno tre fasi pedogenetiche "caldo-umide" a partire dal Pleistocene Medio fino all'inizio dell'Olocene.

Parole chiave - antiche strade, Pleistocene, colore del suolo, resistenza alla penetrazione, Toscana

INTRODUCTION

A previous 2017 survey on the relationships between the Pleistocene paleosols of North- Central Tuscany and the ancient road system (Magaldi *et al*., 2017) revealed that in this part of Tuscany, most of the ancient roads (Etruscan, Roman and Medieval) were plotted on surfaces characterised by the presence of Pleistocene paleosols classified by previous literature as Alfisols and Ultisols. As an example, the Medieval Ghibelline Florence to Poppi Castle road, is here shown (Fig. 1).
These soils, of which traces still exist and of which in some cases it is still possible to excavate profiles, have argillic B-horizons which are red/orange in colour and range from 7.5 YR to 5 YR and more rarely, 2.5 YR (according to the Munsell Soil Color Charts) and are primarily located in the Geological Formation No. 3 of Rusciniano-Villafranchiano age, according to the Geological Map of Carmignani *et al*. of 2012 (Fig. 2).
Using the soil data collected along the ancient roads, the Munsell Soil Color and the Resistance of the soil to Penetration Resistance in Kg/cm^2 (using a pocket penetrometer, after the Field Book by Schoeneberger *et al*., 2002) were reciprocally measured. The Color was expressed as Redness, according to the formula proposed by Torrent & Barron (1993): *Redness = (10-H) x C/V, where H is the number preceding YR in the Munsell Hue, C is the Chroma and V the Value.* The results presented and discussed here were therefore obtained (Tab. 1).

RESULTS

No significant relationship was found between Redness and Penetration single values.It was thus deemed appropriate to subdivide the Redness values in classes based on their frequency distribution. The following classes were obtained: from Redness 0 to 2, n = 7; from 2 to 3, n = 11; from 3 to 4, n =13; more than 4, n = 9. Therefore, the average values of Redness classes were considered in relation to corresponding average values of Resistance (Fig. 3). This graph suggests a correlation between Redness and Resistance classes and thus between the content of pedogenic haematite, after Schwertmann & Taylor, 1989, Schwertmann, 1993, Torrent & Barron, 1993, and the soil resistance to penetration. The chart also reveals the existence of three pedogenetic layers characterised by different Redness values and Penetration Resistance which, based on numerous works in the literature in this regard (Arduino *et al*., 1989; Graham *et al*., 1989; Torrent *et al*., 1980; Duiker, 2003; Kafoor, 2017; Lucke & Sprafke, 2015; Stefanou & Papazafeiriou, 2013), may be attributed to the increasing of level of the soil structuring by effect of pedogenic occurrence of the ironh ydroxides and oxides. Examining now the average Redness values: 3-6; 4; 1; in relation to colour of the sampled paleosols, it can be assumed that the Redness higher values correspond to colors 2.5 YR - 5 YR; the intermediate value to 7.5 YR; the lower value to colors 7.5 YR - 10 YR.

[1] Retired Full Professor of Engineering Geology at the Universities of L'Aquila and Firenze; Firenze, Via Cairoli 7

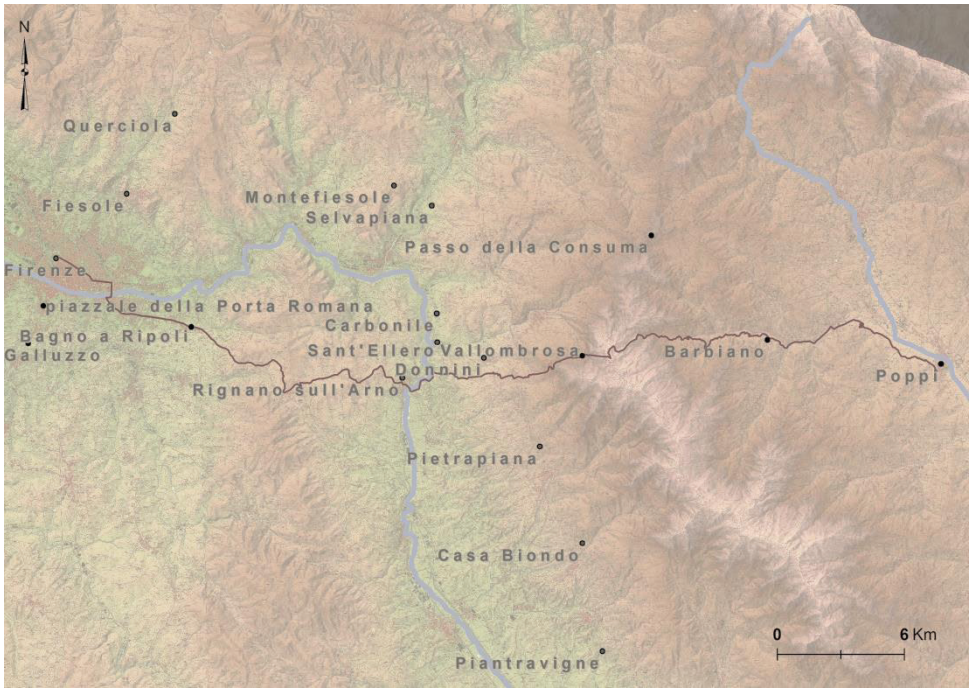

Figure 1. Map of Medieval Ghibelline road from Florence to Poppi Castle.

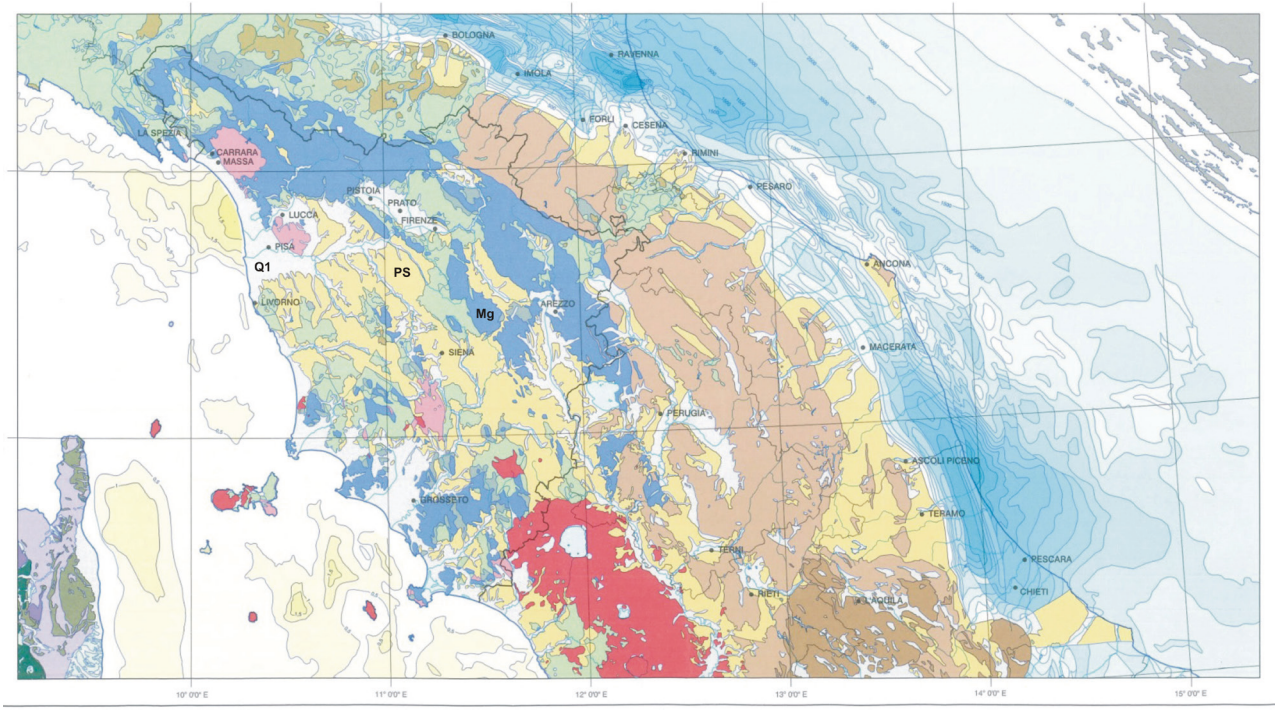

Figure 2. Geological Map after Carmignani *et al.*, 2012, showing location of investigated areas. Q1 = Quaternary Surfaces; PS = Pliocene Surfaces; Mg = Oligocene terraced surfaces from Macigno sandstones.

Table 1. Geographical Location of Sites- Soil Redness –Soil Resistance (Kg/cm2).

1	Altopascio	43°48'	10°40'	5,8	3,5
2	Cecina	43°50'	10°52'	6,0	2,2
3	Serravalle	43°54'	10°50'	2,5	3,4
4	Lamporecchio	43°49'	10°53'	2,5	3,0
5	Castelfiorentino	43°36'	10°58'	4,0	4,5
6	San Gimignano	43°28'	11°02'	0,0	4,0
7	Reggello	43°41'	11°32'	3,5	3,5
8	Casalguidi	43°52'	11°00'	3,0	2,3
8 BIS				7,3	2,3
9	Castelvecchio	43°46'	10°36'	5,5	4,5
10	Ponte a Elsa	43°41'	10°53'	4,0	3,0
11	Veneri	43°23'	10°40'	5,8	4,5
11 BIS				3,0	4,5
11 TRIS				4,0	4,5
12	Galliano	44°	11°17'	5,0	3,3
13	Spedaletto	44°	10°57'	4,0	4,0
14	Polcanto	43°53'	11°21'	4,0	3,1
15	Castiglion Fibocchi	43°31'	11°45'	3,5	3,0
16	Badia al Pino	43°24'	11°46'	0,0	4,5
17	Figline Valdarno	43°37'	11°28'	3,5	2,0
18	Colle Val d'Elsa	43°25'	11°07'	0,0	4,0
19	Tavernelle	43°33'	11°33'	0,0	2,4
19 BIS				4,0	2,8
19 TRIS				10,0	2,9
20	Pietramarina	43°47'	10°58'	2,5	3,0
21	Veneri	43°23'	10°40'	5,8	4,4
21 BIS				3,0	4,0
21 TRIS				6,7	2,0
22	Ponte a Rigoli	44°	11°00'	2,0	3,0
23	Cerreto Guidi	43°05'	10°52'	2,5	3,0
24	Pontepetri	44°	10°53'	3,0	2,9
25	Montaione	43°33'	10°55'	4,0	3,9
25 BIS				3,0	3,5
26	San Miniato	43°41'	10°51'	3,0	3,3
27	Rignano sull'Arno	43°33'	11°27'	3,8	3,3
27 BIS				3,0	2,6
28	Santomoro	43°58'	11°00	3,3	3,0
29	Cascina di Spedaletto	44°	11°00'	2,0	3,3
30	Baggio	44°	11°00'	4,0	3,0
31	Barberino di Mugello	44°	11°14'	2,0	4,5

Discussion

The compiled data were derived from a series of point observations performed for various reasons on some paleosols found along the traces of the ancient roads and are characterised by progressively redder colouration starting from 10 YR. It is well known that various A.A. in both Europe and the United States have highlighted significant relationships between color, expressed by a complex *rubification index* (Rubification, by Vadic, 1998), by the indexes of Torrent & Barron (1993), or more simply by the "Hue" score of the Munsell Soil Color Charts, and the age of Paleosols, generally formed from siliciclastic deposits, of the Pleistocene or more recent ages (Bech *et al*., 1997; Markewich *et al*., I and II, 1987). The results of this survey revealed that in the examined territory, a series of point data (and random data for certain aspects) made it possible to identify traces of three pedogenic phases. Based on the Author's experience in soil surveys and that of Colleagues at the University of Florence (Bartolini *et al*., 1980; Cremaschi, 1987; Ferrari & Magaldi, 1978; Ferrari *et al*., 1971; Galligani, 1971; Lulli *et al*., 1980; Magaldi, 1979; Magaldi *et al*., 1981; Magaldi *et al*., 1983; Magaldi *et al*., 1985; Magaldi & Bidini, 1991; Magaldi *et al*., 1988; Magaldi, 1993; Pontenani, 1992), the phases are identified as probable Middle Pleistocene for the first, Upper Pleistocene for the second and late Pleistocene-Holocene, for the third. These paleosols have a "moderate" compression resistance as suggested by the Field Book (Schoeneberger *et al*., 2002) in proportion to the content of iron oxides and hydroxides of pedogenetic origin and in part to the clays neoformation. By comparing these paleosols dated up to this point using geomorphological criteria and/or based on the remains of prehistoric industry with similar soils in Italy (Magaldi, 1979; Cremaschi, 1987), Slovenia (Vidic, 1998) and in the Southern United States (Markewich *et al*., 1987), an absolute chronological attribution may be attempted, although on an indicative basis: the absolute age of the first pedogenic phase expressed in years should correspond to less than 10^4 years; from 10^4 to 10^5 for the second; and more than 10^5 years for the third.

Concluding remarks

The results obtained through averaged values from a population of data collected randomly (although primarily on a single Quaternary surface) confirm the initial hypotheses on the relationships between soil Redness and soil Resistance suggesting also that the old roads were constructed favouring the choice of flat surfaces with"red" paleosols still well preserved and with good mechanical properties.

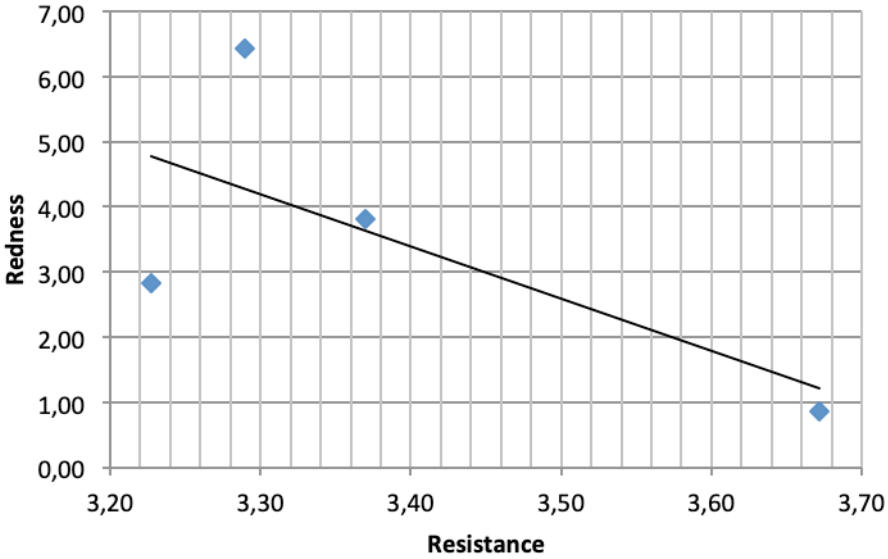

Figure 3. Soil Resistance to Penetration vs. Soil Redness.

These short notes can therefore represent a starting point for similar research in other Italian regions and an introduction to the paleosols absolute dating. It is probable that the three phases succeeded each other without particular interruption by virtue of that complex of pedogenic processes typical of strongly Mediterranean or Subtropical environments which, from primitive Inceptisols (embryonic soils with few diagnostic features), originated Alfisols (high base status forest soils) and finally Ultisols (low base status forest soils, sometimes with plinthite forms) (Buol *et al*., 1980; Fitzpatrick, 1985; Smeck *et al*., 1983). Some photos of examined paleosols are shown in Appendix.

REFERENCES

Bartolini C., Bidini D., Ferrari G.A, Magaldi D., 1980. Pedostratigrafia e Morfostratigrafia nello studio delle superfici sommitali situate fra Serchio e Ombrone pistoiese. *Geografia Fisica e Dinamica Quaternaria*.

Bech J., Rustullet J., Garrigò F., Tobias J., Martinez R., 1997. The iron content of some red Mediterranean soils from northeast Spain and its pedogenic significance. *Catena* 28: 211-229.

Buol S.W., Hole F.D., McKracken R.J., 1980. Soil Genesis and Classification. The Iowa State University Press, Ames, 406 pp.

Carmignani L., Conti P., Cornamusini G., 2012. Carta Geologica della Toscana. CGT, Centro di Geotecnologie, Università di Siena.

Cremaschi M., 1987. Paleosols and Vetusols in the Central Po Plain (Northern Italy). A study in Quaternary Geology and Soil Development. Edizioni UNICOPLI, Milano, 306.

Duiker S.W., Rhoton F.E., Torrent J., Smeck N.E., Lal R., 2003. Iron(Hydr)Oxide Crystallinity Effects on Soil Aggregation. *Soil Sci. Soc. of Am.* 67: 606-611.

Ferrari G. & Magaldi D., 1978. Sedimentologia e micropedologia dei paleosuoli sul terrazzo principale della Val di Chiana (Arezzo). *Geografia Fisica e Dinamica Quaternaria* 63-73.

Ferrari G., Magaldi D., Raspi A., 1971. Studio pedologico del paleosuolo di Monte Longo (Siena). *Atti della Società Toscana di Scienze Naturali. Memorie. Serie A* 78: 395-419.

Fitzpatrick, R.W., 1985. Iron compounds as indicators of pedogenic processes: Examples from the Southern Hemisphere. In: Iron in Soils and Clay Minerals, edited by J.W. Stucki, B.A. Goodman, and U. Schwertmann, pp. 351-396, Dordrecht, The Netherlands.

Galligani U., 1971. Paleosuoli e terrazzi fluviali in Casentino. *Memorie Società Geologica Italiana* 10: 247-256.

Kafoor S., 2017. Iron Oxide contents in relation to Colour of Asnawa Soils. *UKH Journal of Science and Engineering* 1: 89-94.

Lucke B., Sprafke T., 2015. Correlation of soil colour, redness rating and weathering indices of Terrae Calcis along a precipitation gradients in northern Jordan. *Erlanger Geographische Arbeiten Band* 42: 53-68.

Lulli L., Lorenzoni P., Arretini A., 1980. Esempi di cartografia tematica e di cartografia derivata (Sezione Lucignano –Foglio Firenze). La carta dei suoli, la loro capacità d'uso, l'attitudine dei suoli all'olivo e al Sangiovese. Messa a punto di metodologie di rilevamento e di rappresentazione. Istituto Sperimentale per lo Studio e la Difesa del Suolo. CNR, Unità operativa 14, Pubb. n. 56. Firenze.

Magaldi D., 1979. Paleosuoli e stratigrafia del Quaternario continentale. *Ateneo Parmense, Acta Naturalia* 15: 159-161, 161 X.

Magaldi D., 1993. Indizi di paleo pedogenesi in un suolo bruno acido della Foresta di Vallombrosa (Firenze). *Il Quaternario* 6: 205-212.

Magaldi D., Angeli A., Bidini D., Brandini P.G., Magazzini P., 1985. I suoli dell'alveo del Bientina e delle colline a sud ovest di Massarella nella Bassa Valle dell'Arno: genesi, cartografia, problemi d'uso. *Annali dell'Istituto Sperimentale per lo Studio e la Difesa del Suolo* 16: 1-29.

MAGALDI D., BAZZOFFI P., BIDINI D., FRASCATI F., GREGORI E., LORENZONI P., MICLAUS N., ZANCHI C., 1981. Studio interdisciplinare sulla classificazione e la valutazione del territorio: un esempio nel Comune di Pescia (Pistoia). *Annali dell'Istituto Sperimentale per lo Studio e la Difesa del Suolo* 12: 31-114.

MAGALDI D., BIDINI D., 1991. Microscopic and sub microscopic characterization of a well-developed plinthite in a buried Middle Pleistocene soil of Northern Tuscany. *Quaderni di Scienza del Suolo CNR* 3: 31-44.

MAGALDI D., BIDINI D., CALZOLARI C., RODOLFI G., 1983. Geomorfologia, suoli e valutazione del territorio tra la piana di Lucca e il Padule di Fucecchio. *Annali dell'Istituto Sperimentale per lo Studio e la Difesa del Suolo* 14, 1-38.

MAGALDI D., BOLOGNESI A., ARFAIOLI P., ARGENTO L., AZZARI M., 2017. Relazioni tra paleosuoli pleistocenici della Toscana centro-settentrionale e la viabilità antica. GF Press, Serravalle Pistoiese, 64 pp.

MAGALDI D., CALÒ I., INNOCENTI L, RASPI M.A., 1988. Proposte per una metodologia di ricerca finalizzata alla classificazione ingegneristica del territorio. *Bollettino Servizio Geologico d'Italia* CVII: 225-252.

MAGALDI D., TALLINI M., 2000. A micromorphological index of soil development for the Quaternary geology research. *Catena* 41: 261-276.

MARKEWICH H.W, PAVICH M.J., MAUSBACH M.J., JOHNSON R.G, GONZALEZ V.M., 1987. I & II.A. Guide for Using Soil and Weathering Profile Data in Chronosequence Studies of the Coastal Plain of the Eastern United States. *U.S. Geological Survey Bulletin* 1589, D.

PONTENANI C., 1992. I suoli forestali delle colline a Nord di Monteriggioni: caratteristiche, distribuzione e relazioni con il paesaggio. Tesi di Laurea inedita in Scienze Forestali dell'Università di Firenze.

SCHOENEBERGER P.J., WYSOCKI D.A., BENHAM E.C., BRODERSON W.D. (Editors), 2002. Field book for describing and sampling soils. Vers. 2.Natural Resources Conservation Service, National Soil Soil Survey Center, Lincoln, USA.

SCHWERTMANN U., 1993. Relations between Iron Oxides, Soil Color and Soil Formation. In: J.M. Bingham and E.J. Ciolkosz (eds.): Soil Color, SSSA Special Publication 31, Madison, USA.

SCHWERTMANN U., TAYLOR R.M, 1989. Iron oxides in Minerals Soil Environments, 2nd ed., pp. 379-438, *Soil Sci. Soc. of Am.*, Madison, Wis. USA.

STEFANOU S., PAPAZAFEIRIOU A., 2013. Effect of iron and aluminium oxides and clay content on penetration resistance of five Greeks soils. *Eurasian Journal of Soil Science*: 122-130.

TORRENT J., BARRON V., 1993. Laboratory Measurement of Soil Color: Theory and Practice. *Soil Sci. Soc. of Am.*: 677-685.

VIDIC N., 1998. Soil-age relationships and correlations: comparison of chronosequences in the Ljubljana Basin, Slovenia and USA. *Catena* 34: 113-129.

(ms. pres. 12 aprile 2019; ult. bozze 1 ottobre 2019)

Appendix

Foto 1. Francigena Road of Sambuca (PT).

Foto 2. Ultisol on a Monte Albano (PT) low terrace.

Foto 3. The cobbled surface of Baiana Road near Pistoia.

Foto 4. The cobbled surface of Francigena Road near Galleno (LU).

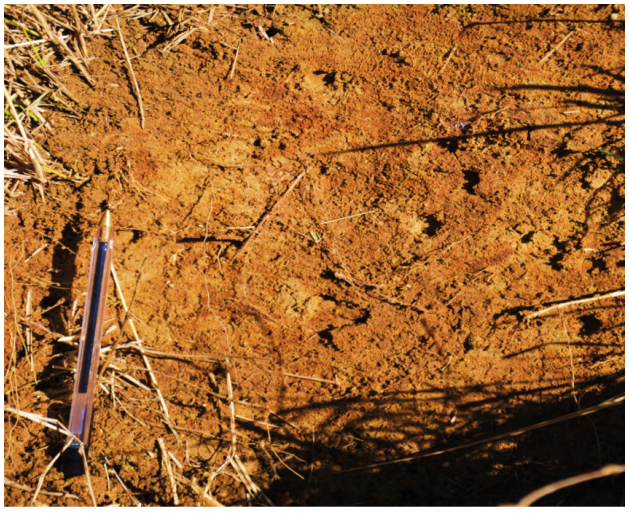

Foto 5.Alfisol on terrace derived from Macigno sandstone (Monte Longo (AR).

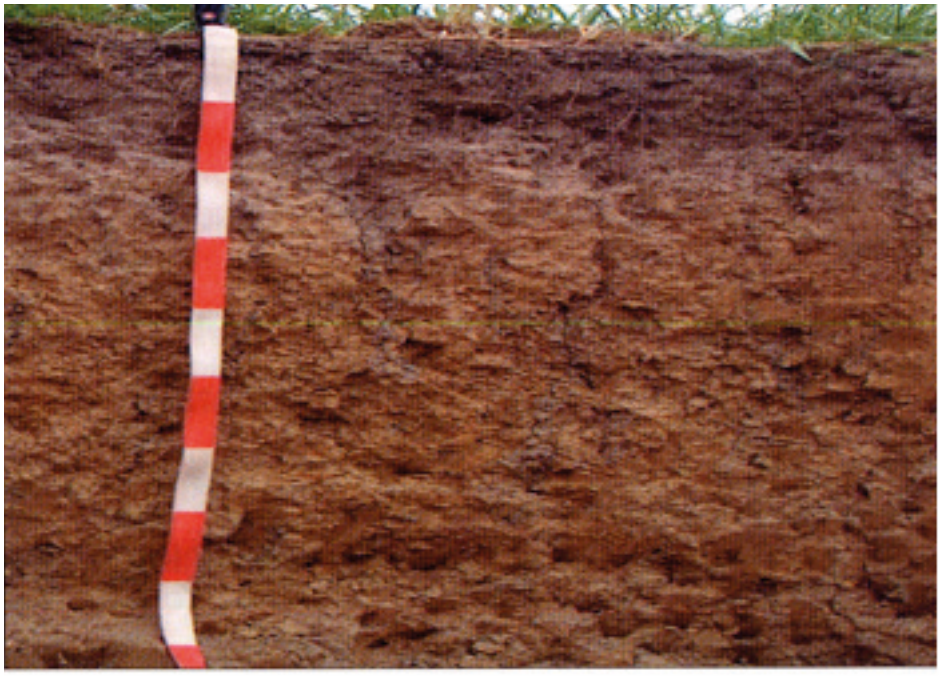

Foto 6. Luvisol with clear horizon differentiation near Castelfranco di Sotto (AR).

Edizioni ETS
Palazzo Roncioni - Lungarno Mediceo, 16, I-56127 Pisa
info@edizioniets.com - www.edizioniets.com
Finito di stampare nel mese di dicembre 2019