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CALIBRATION OF OSL DATA: MISMATCH BETWEEN STRATIGRAPHY AND OSL CHRONOLOGY OF SEDIMENTS FROM THE PO PLAIN

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ABSTRACT: Panzeri L. *et al., Calibration of OSL data: mismatch between stratighraphy and OSL chronology of sediments from Po Plain.* (IT ISSN 0394-3356, 2011)
We present the results obtained with Optically Stimulated Luminescence (OSL) on alluvial sediments from Po Plain. The ages obtained are in good agreement with stratighraphic position and with radiocarbon ages for the younger samples (latest Pleistocene) while there is an underestimation for the oldest samples (middle Pleistocene). The cause of this behaviour is discussed.

RIASSUNTO: Panzeri L. *et al., Calibrazione di date ottenute mediante OSL: disaccordo tra la stratigrafia e la cronologia OSL di sedimenti della Pianura Padana.* (IT ISSN 0394-3356, 2011)
Vengono presentati i risultati ottenuti mediante Luminescenza Otticamente Stimolata (OSL) applicata a sedimenti alluvionali provenienti dalla Pianura Padana. Le età ottenute sono in accordo con la posizione stratigrafica e con i dati ottenuti mediante radiocarbonio per i campioni più giovani (Pleistocene Superiore) mentre sono sottostimate per i campioni appartenenti al Pleistocene Medio. Le possibili cause di tale comportamento sono discusse.

Key words: alluvial sediments, OSL dating, Po plain, Quaternary

Parole chiave: sedimenti alluvionali, datazione OSL, Pianura Padana, Quaternario

We applied OSL dating techniques to quartz samples from some outcrops in the alluvial Quaternary succession of the Po plain South of Milan, to assist the stratigraphic reconstruction. Luminescent dating is in fact used to determined burial ages of sediments that were exposed to sunlight prior to deposition (AITKEN, 1998). Primarily we aimed at obtaining new age determinations to tighten the chronological constraints that are traditionally applied to some crucial stratigraphic units, exposed at the so-called "Livello Fondamentale della Pianura (LFP)" (CASTIGLIONI & PELLEGRINI, 2001). We focused on three exposures, close to the southern end of the LFP, in different tectono-stratigraphic settings. From SW to NE we sampled: i) the Middle Pleistocene alluvial sediments in a quarry exposure at the northern flank of the san Colombano al Lambro isolated hill (DESIO, 1965), a spur of an Apenninic thrust front of the Western Emilia folds that was active during Middle and presumably Late Pleistocene (PELLEGRINI *et al.*, 2003), ii) the Middle Pleistocene alluvial sediments of the Casalpusterlengo relic relief ("Mindel" Auct., CREMASCHI, 1987), at the top of an Apenninic anticline, kinematically linked to the San Colombano structure (BERSEZIO *et al.*, 2010), and iii) the top of the Late Pleistocene sediments of the LFP in the Lodi depocentre, just South of the interference zone between the Alpine and Apenninic thrust fronts. These deposits have been indicated on the various geological maps at scale 1:100.000, but with a poorly defined age (CREMASCHI, 1987).

Five samples were collected by hammering steel tubes into freshly cleaned exposures. The tubes were capped with aluminum sheets and sealed using black plastic bags. Samples GeMa1 and GeMa2 can be ascribed to the younger Cantù Alloformation (latest Pleistocene, STRINI, 2001), while samples GeSo1 and GeSo2 belong to the Casalpusterlengo relic relief ("Mindel" Auct., CREMASCHI, 1987). Sample GeBF was taken from the middle Pleistocene Cascina Parina Unit (PELLEGRINI *et al.*, 2003) at the northern flank of the san Colombano al Lambro hill. Tab. 1 summarises the stratigraphic position, the main sedimentological characteristics of the samples and their depositional environment.

The quartz extraction was made following the conventional procedure (LANG *et al.*, 1996). All the luminescence measurements were conducted on coarse quartz grains (75–120 μm). The single-aliquot regenerative-dose (SAR) protocol was used to determine the radiation dose absorbed by sediment grains since deposition (MURRAY & WINTLE, 2000).

The OSL measurements were made using an automated luminescence system (Risø TL/OSL-DA-15), equipped with a $^{90}Sr/^{90}Y$ beta source delivering 0.14 Gy/s (±3%) to the sample position. The quartz OSL was stimulated by an array of blue LEDs (470±30 nm) for 100 s at 125°C with a constant stimulation power of 54 mW/cm^2. The

Site	Sample	Sampling depth (cm)	Stratigraphic position	Description	Dep. environment and pedological interpretation	OSL age (ka)
LFP Mairago (Lodi).	GeMa2	150	Cantù Alloformation (latest Pleistocene).	Yellowish gray sandy silt and clay, massive, with red mottling, clay coatings and Fe-Mn nodules.	Fluvial; pedogenic features indicate formation of an hydromorphic soil.	19 ± 2
LFP Mairago (Lodi).	GeMa1	250	Cantù Alloformation (latest Pleistocene).	Greyish brown, coarse-grained silty sand with grey to red mottling, clay coatings and Fe-Mn nodules.	Fluvial; pedogenic features indicate formation of an hydromorphic soil.	16 ± 2
Casalpusterlen go relic relief. Costa Fagioli.	GeSo2	420	Isolated terraces Fluvial Formation (middle Pleistocene; Cremaschi, 1987).	Coarse to medium-grained, massive sand with normal grading and mud chips at the bottom; red ferruginous mottling, clay coatings and Fe-Mn concretions.	Alluvial; pedogenic features indicate formation of polycyclic fersiallitic paleosol with alluvial clay horizon.	67 ± 6
Casalpusterlen go relic relief. Costa Fagioli.	GeSo1	500	Isolated terraces Fluvial Formation (middle Pleistocene; Cremaschi, 1987).	Coarse to medium-grained, normally graded gray sand with cross-lamination; ferruginous concretions at the bottom.	Alluvial.	107 ± 13
C.na Belfuggito.	GeBF	620	Cascina Parina Unit (middle Pleistocene; Pellegrini et al., 2003).	Fine to coarse-grained pebbly sands with fine planar lamination and soft sediment deformation.	Alluvial.	89 ± 9

Tab. 1. Stratigraphic constraints and OSL age determinations obtained at the sampling sites.
Posizione stratigrafica, descrizione ed età OSL dei campioni.

presence of feldspars was checked using an IR diode array (830±10 nm) with a stimulation power of 360 mW/cm^2. Photons were detected by a bialkali photomultiplier tube (EMI 9235QB15) coupled to a 7.5 mm Hoya U-340 filter. The preheat was at 180°C for 10 s for samples GeMa1 and GeBF and 200°C for the other samples. To control the purity of the extracted quartz, the OSL-IR-depletion ratio test (DULLER, 2003) was performed. IRSL signals were observed in all samples. To reduce its presence another HF etching for 40 min was attempted and the test remade. Nevertheless, all samples showed again a significant contribution due to feldspars. For this reason anomalous fading was tested using delayed Lx/Tx measurements with delays of up to 1 month.

The samples were initially tested using preheat plateau and dose recovery tests.

In order to calculate the annual dose, the Th and U concentrations of the sediments were measured with total alpha counting using ZnS scintillator discs (AITKEN, 1985), assuming a concentration ratio Th/U equal to 3. ^{40}K content was deduced from the total concentration of K that was measured with flame photometry. Attenuation of the beta dose was taken into account (BELL, 1979). The contribution of cosmic radiation was taken as 0.15 mGy/a at depths of about 1 m. For greater depths attenuation factors were used (AITKEN, 1985). The results of radioactivity measurements together with the corresponding dose rates are reported in Tab. 1. In calculating the dose-rates, it was assumed that the average water content over the entire burial period was about 20% for all samples except for GeMa1 (30%).

The OSL age obtained are listed in Tab.1. Samples GeMa1 and GeMa2 yielded OSL ages in good agreement with the stratigraphic position and calibration by radiocarbon ages (BERSEZIO *et al.*, 2004). Differently the OSL ages of the other samples do not fit the available stratigraphic constraints (late Pleistocene instead of the expected middle Pleistocene). Different explanations can be claimed as indicated by recent literature: 1) the samples are too old to be dated by OSL technique. Despite the samples haven't reached the saturation and have met the standard performance criteria set to test the reliability of the SAR protocol, they showed underestimation. (BUYLAERT *et al.*, 2007; MURRAY *et al.* 2007; LOWICK *et al.*, 2010); 2) Some quartz has luminescence properties that make it problematic for dating application. In fact, despite the fact that quartz is nominally pure SiO2, the mineral forms in several different geological settings. The luminescence properties of quartz are highly variable with geological source and vary even at a grain to grain level within a sediment (GOTZE *et al.*, 2005; PREUSSER *et al.*, 2009) 3) the samples belong to complex pedogenetic profiles. The role of weathering and water adsorption by quartz grains on OSL luminescence is still poorly understood.

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