How to reconcile OSL and TCN data?

the potential of high resolution sampling on the Choshuei Tableland (West Central Taïwan)

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https://thegateproject.cerege.fr/
We propose to develop complementary approaches to accurately date seismic-related late-Quaternary morphological surfaces related to through an exhaustive, detailed and unique direct comparison of TCN and OSL dating methods, which are often in disagreement.

https://thegateproject.cerege.fr/
OSL settings

As previous works have shown the difficulties of OSL dating in Taiwan, particular attention has been paid to luminescence characteristics of quartz and potential dosimetry issues.
Our study case is located in Western Foothills of Central Taiwan, south of the Choushui River.

There, slip on the Changhua blind thrust fault has caused the eastward tilt of a wide flight of fluvial terraces but slip rates on frontal faults are still debated due to large epistemic uncertainties in dating alluvial surfaces with OSL and TCN methods.
Alluvial terraces in Western Foothills

Previous geochronological works done in the area

data from:
Ota et al., 2002
Simoes et al., 2007
Siame et al., 2012
Poujol et al., 2018

Horizontal distance (km)

EGU 2020 - RIZZA et al.
Taking advantage of a natural exposure, we collected 10 samples for $^{10}$Be dating complemented by 14 OSL samples along a 7m-depth profile.
TCN Results and interpretation

The depth distribution of $^{10}$Be concentrations show a complex depositional history with at least two depositional sequences, modelled to be older than $\sim 38.7$ ka and $\sim 50$ ka.

For more details in TCN modelling see methodology described in Fig. 8 from Rizza et al. (2019) DOI: 10.1029/2018TC005188

$\chi^2 : 0.71$

$T \sim 38.7$ ka

$\varepsilon = 0$

Erosional surface

Steady-state?

$T_{min} \sim 50$ ka

$\varepsilon = 351$ m/Ma
Dose rate determination

In-situ measurements made with a portable gamma spectrometer (not for OSL 1 to 3)

Canberra InSpector1000 gamma spectrometer
Dose rate determination

In-situ measurements made with a gamma spectrometer

ICP-MS and ICP-OES measurements (in a log scale)

Dose rate determination (Gy/ka)

Lebrun et al., in prep

We then propose to define 3 stratigraphic units...
Equivalent dose determination

Measurements are made in a new OSL lab at CEREGE, Aix-en-Provence, France.
Equivalent dose determination

Components study: fast ratio investigations

OSL signal consists of three components: a fast, a medium and a slow one... Our deepest samples present a signal with medium and slow components, characteristics not seen in upper samples.

Equivalent dose determination

Dose recovery ratio (DRR)

Two clear types of quartz behavior: classical in US1/2 and challenging in US3

EGU 2020 - RIZZA et al.
Equivalent dose determination

<table>
<thead>
<tr>
<th>US1</th>
<th>US2</th>
<th>US3</th>
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<tbody>
<tr>
<td><strong>Dose recovery ratio (DRR)</strong></td>
<td><strong>Equivalent Dose (Gy)</strong></td>
<td><strong>OSL ages</strong></td>
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<td></td>
<td></td>
<td><strong>with gamma spectrometer</strong></td>
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<tr>
<td>CS2-OSL4</td>
<td>20.02 ± 0.88 Gy</td>
<td>9.72 ± 0.89 ka</td>
</tr>
<tr>
<td>CS2-OSL9</td>
<td>54.94 ± 4.91 Gy</td>
<td>23.2 ± 2.42 ka</td>
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<tr>
<td>CS2-OSL10</td>
<td>87.3 ± 16.79 Gy</td>
<td>47.36 ± 7.05 ka</td>
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<tr>
<td>CS2-OSL1</td>
<td>107.75 ± 10.00 Gy</td>
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</tr>
<tr>
<td>CS2-OSL2</td>
<td>163.37 ± 13.23 Gy</td>
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Interpretation: three depositional units (US1, US2, US3), dated between ~9 ka and ~66 ka, that are evidenced by different OSL signal characteristics and variations in dosimetry.
Results and interpretation

OSL ages with gamma spectrometer

- CS2-OSL4: 9.72 ± 0.89 ka
- CS2-OSL9: 23.2 ± 2.42 ka
- CS2-OSL10: 47.36 ± 7.05 ka
- CS2-OSL1: > 49.38 ± 4.98 ka
- CS2-OSL2: > 65.88 ± 5.67 ka

T ~ 38.7 ka
Tmin ~ 50 ka

14C: ~ 31 ka
Ota et al., 2002

US2 age in accordance with 14C from Ota et al., 2002

OSL signal characteristics may not be suitable for dating in lower deposits?

Age differences between these two methods may relate to the erosion-transport-deposition processes experienced by the sediment prior its final deposition.

- Stratigraphically consistent in accordance with the observed stratigraphic units
- US2 age in accordance with 14C from Ota et al., 2002
- OSL signal characteristics may not be suitable for dating in lower deposits?
Results and interpretation

This study shows that it is informative to have an exhaustive, detailed, and direct comparison between dating methods on a single depth profile and allow a more detailed understanding of processes affecting alluvial deposits ... with a more complex history than expected: 4 stratigraphic units and possible changes in the primary sources of the sands.

Abandonment of the alluvial terrace by the river

Erosional surface

Change in sediments sources? (changes in OSL characteristics)
Perspectives

1) Dating our other OSL samples (in progress)
2) Overcome OSL signal difficulties of lower unit

- Look for high saturating quartz: the super-grain technique
- Use small sized grain
- Investigate $D_e$ distributions (single-grain)
- Take advantage of new OSL signals (TT-OSL, VSL)
- Make use of k-feldspars (IRSL)