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Semi-automated fault system extraction and displacement analysis of an excavated oyster reef using high-resolution laser scanned data

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In this contribution we present a semi-automated method for reconstructing the brittle deformation field of an excavated Miocene oyster reef, in Stetten, Korneuburg Basin, Lower Austria.
Oyster shells up to 80 cm in size were scattered in a shallow estuarine bay forming a continuous and almost isochronous layer as a consequence of a catastrophic event in the Miocene. This shell bed was preserved by burial of several hundred meters of sandy to silty sediments. Later the layers were tilted westward, uplifted and erosion almost exhumed them. An excavation revealed a 27 by 17 meters area of the oyster covered layer.
During the tectonic processes the sediment volume suffered brittle deformation. Faults mostly with some centimeter normal component and NW-SE striking affected the oyster covered volume, dissecting many shells and the surrounding matrix as well. Faults and displacements due to them can be traced along the site typically at several meters long, and as fossil oysters are broken and parts are displaced due to the faulting, along some faults it is possible to follow these displacements in 3D.
In order to quantify these varying displacements and to map the undulating fault traces high-resolution scanning of the excavated and cleaned surface of the oyster bed has been carried out using a terrestrial laser scanner. The resulting point clouds have been co-georeferenced at mm accuracy and a 1mm resolution 3D point cloud of the surface has been created. As the faults are well-represented in the point cloud, this enables us to measure the dislocations of the dissected shell parts along the fault lines.
We used a semi-automatic method to quantify these dislocations. First we manually digitized the fault lines in 2D as an initial model. In the next step we estimated the vertical (i.e. perpendicular to the layer) component of the dislocation along these fault lines comparing the elevations on two sides of the faults with moving averaging windows. To estimate the strike-slip dislocation component, the surface points of the dissected shells on both sides of the fault planes were compared and displacement vectors were derived. The exact orientation of the fault planes cannot be accurately extracted automatically, so the distinction between normal and reverse fault is difficult. This makes the third component of the dislocation to be estimated inaccurately.
These derived dislocation values are regarded as components of the dislocation vectors and were transformed back to the real world spatial coordinate system.
Interpolating these dislocation vectors along fault lines we calculated and visualized the deformation field along the whole surface of the oyster reef. Although this deformation field is only a 2D section of the real 3D deformation field, its elaboration reveals the spatial variability of the deformation according to sediment inhomogeneity.
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