SINGLE-EVENT THROW DISTRIBUTION ALONG THE DELTA FAULT (BAIKAL RIFT) FROM GEOMORPHOLOGICAL AND GROUND-PENETRATING RADAR INVESTIGATIONS

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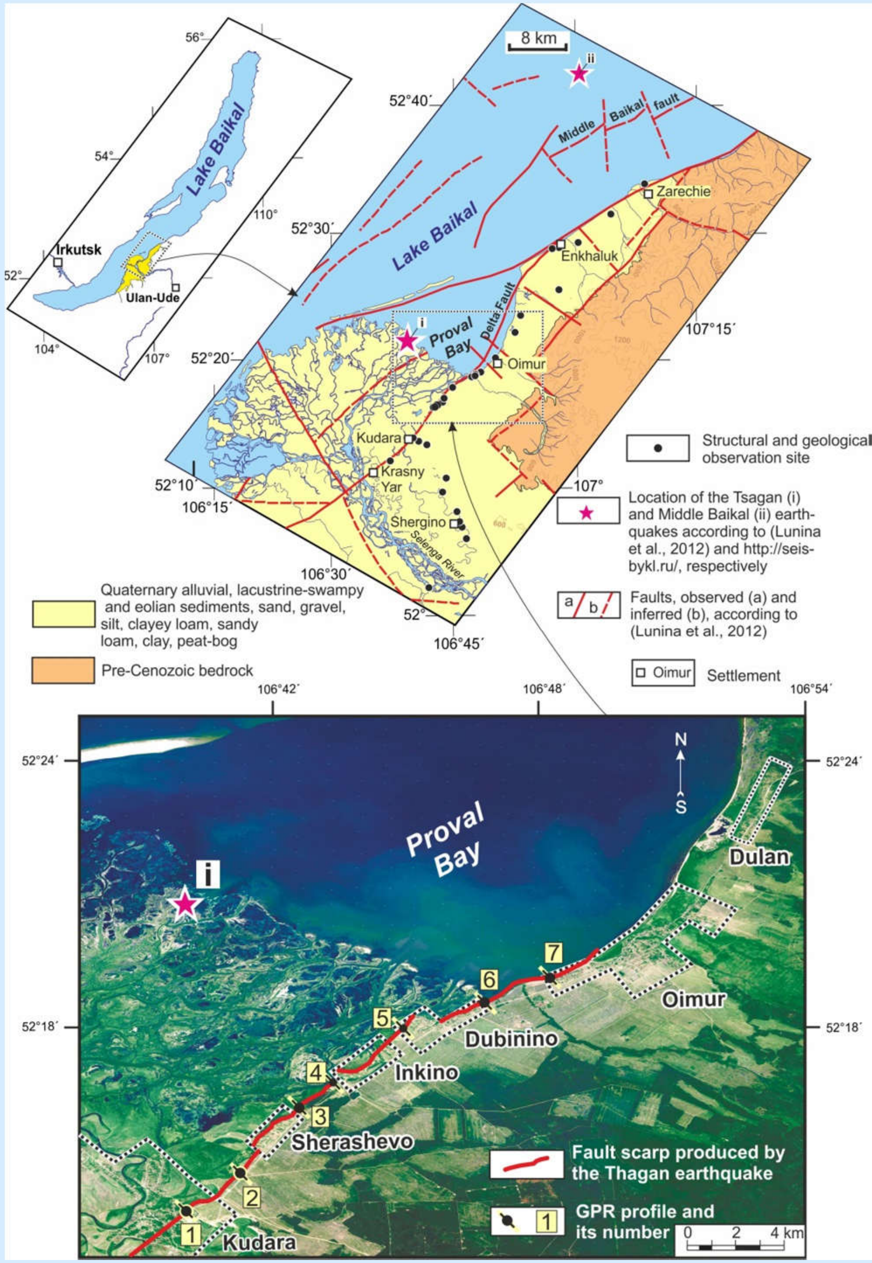
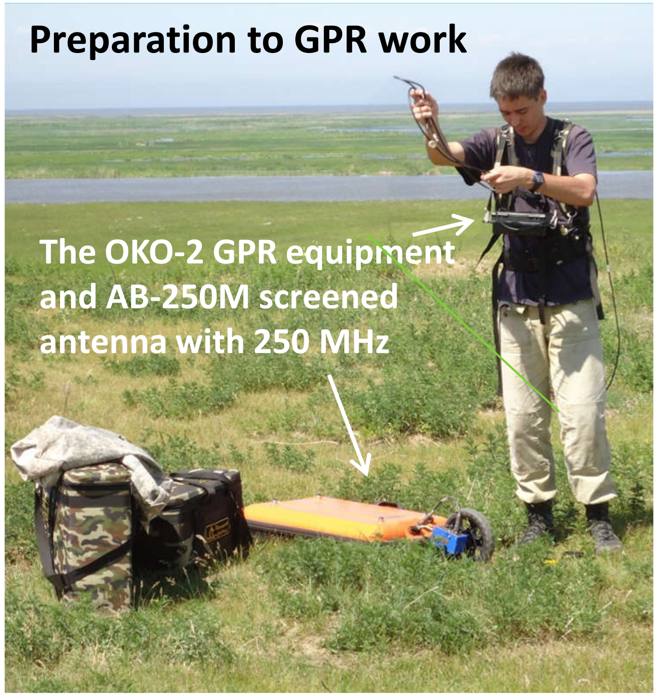
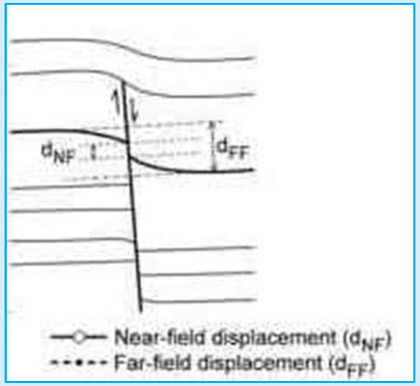
Tectonic displacement is one of the important parameters in determining the seismic potential of an active fault. Its distribution along the fault strike is highly variable; therefore, when assessing seismic hazard, both the quality and the number of measurements of single-event throws are essential. We reconstructed and studied peculiarities of distribution of vertical displacements, which occurred on the land-based part of the Delta fault during the devasting M~7.5 Thagan earthquake of 12 January 1862 produced Proval Bay. Morphologically, the seismogenic structure is expressed by the fault scarp in unconslolidated Holocene sediments, which underwent significant liquefaction and fluidization during the seismic event. In space, the fault scarp coincides with the lacustrine-deltoid and alluvial-deltoid terraces of Lake Baikal and the Selenga river and complicated by eolian deposits.



Location of the fault Delta fault and GPR profiles (background image from Google Earth)

As a basic method, we used ground-penetrating radar (GPR) in combination with data from shallow drilling, trenching and analysis of seven topographic profiles. By measuring near-field displacements at the fault planes (brittle component) and far-field displacement at a distance from the fault plane (sum of brittle and ductile components according to Homberg et al. (2017)) on GPR sections, we subtracted folding component of the total throw.



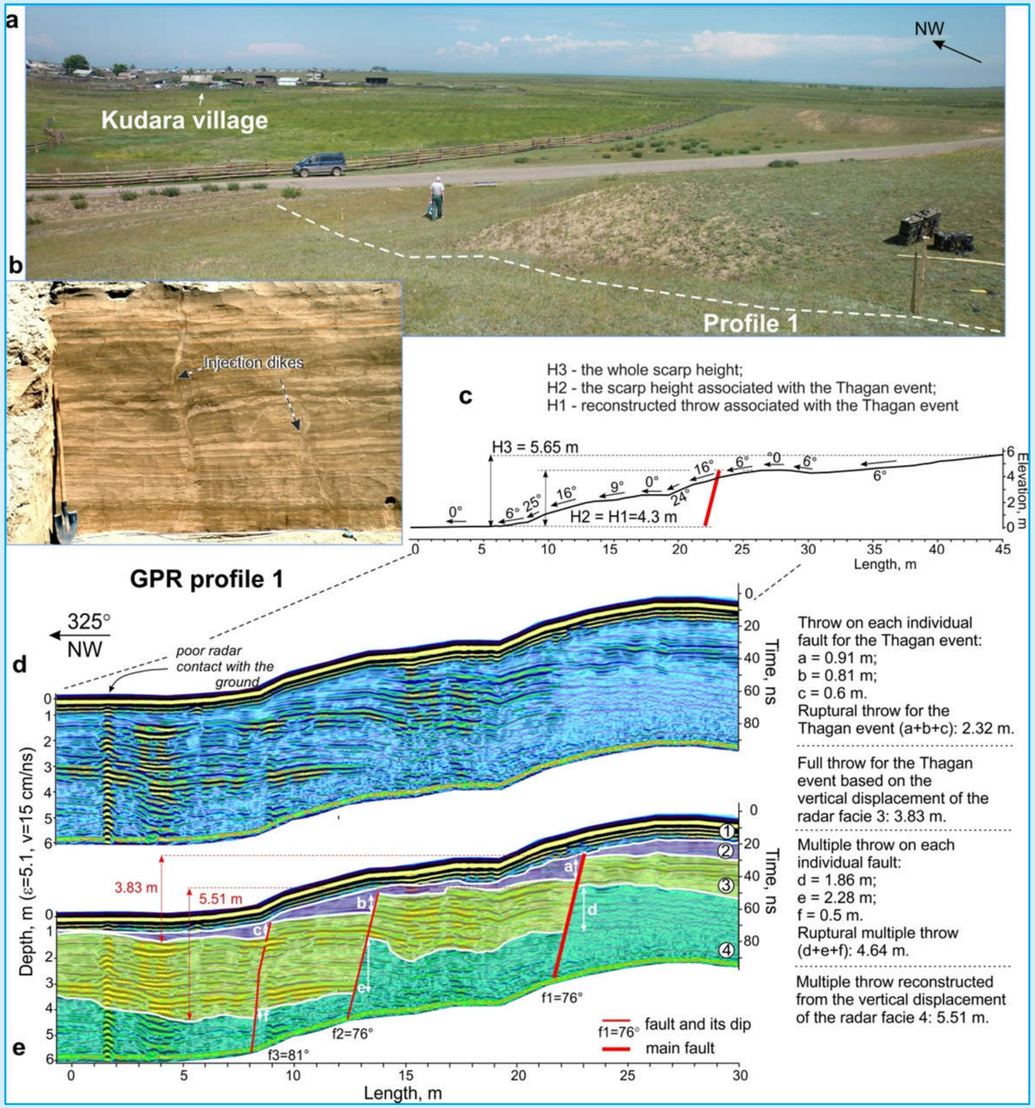


The procedure for displacement data acquisition according to:

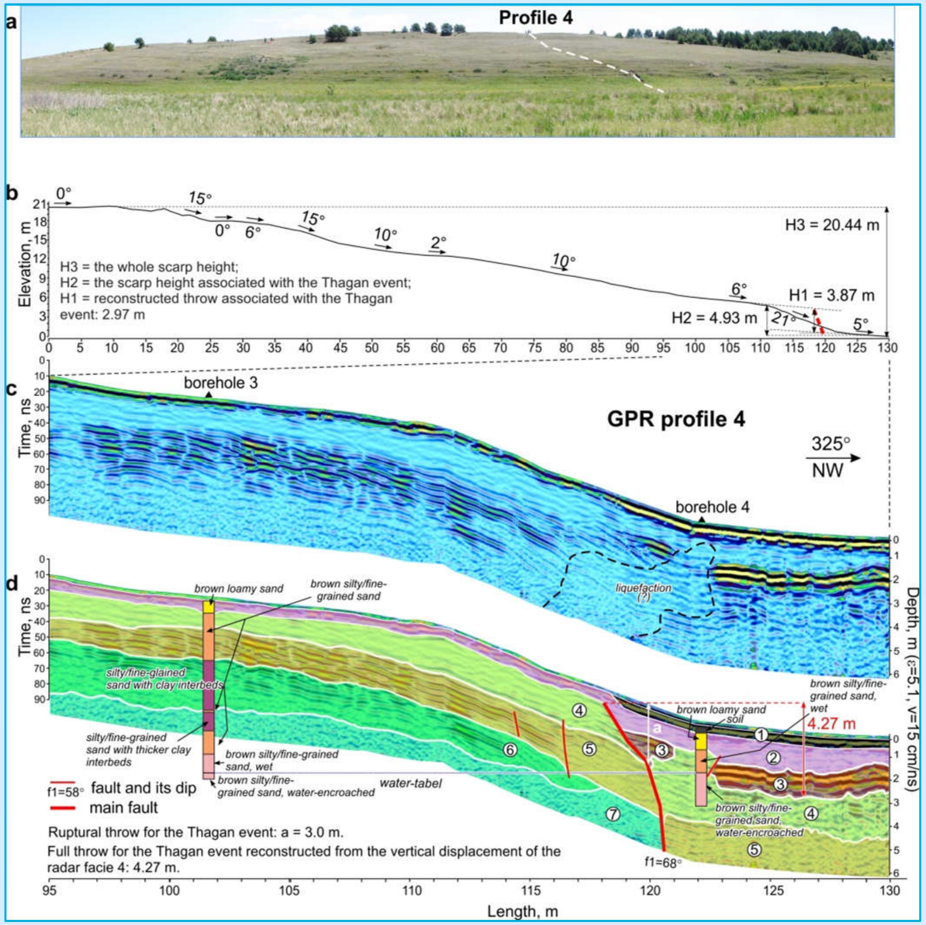
Homberg, C., Schnyder, J., Roche, V., Leonardi, V., Benzaggagh, M., 2017. The brittle and ductile components of displacement along fault zones. Geol. Soc. Lond., Special Publications 439, 395-412.

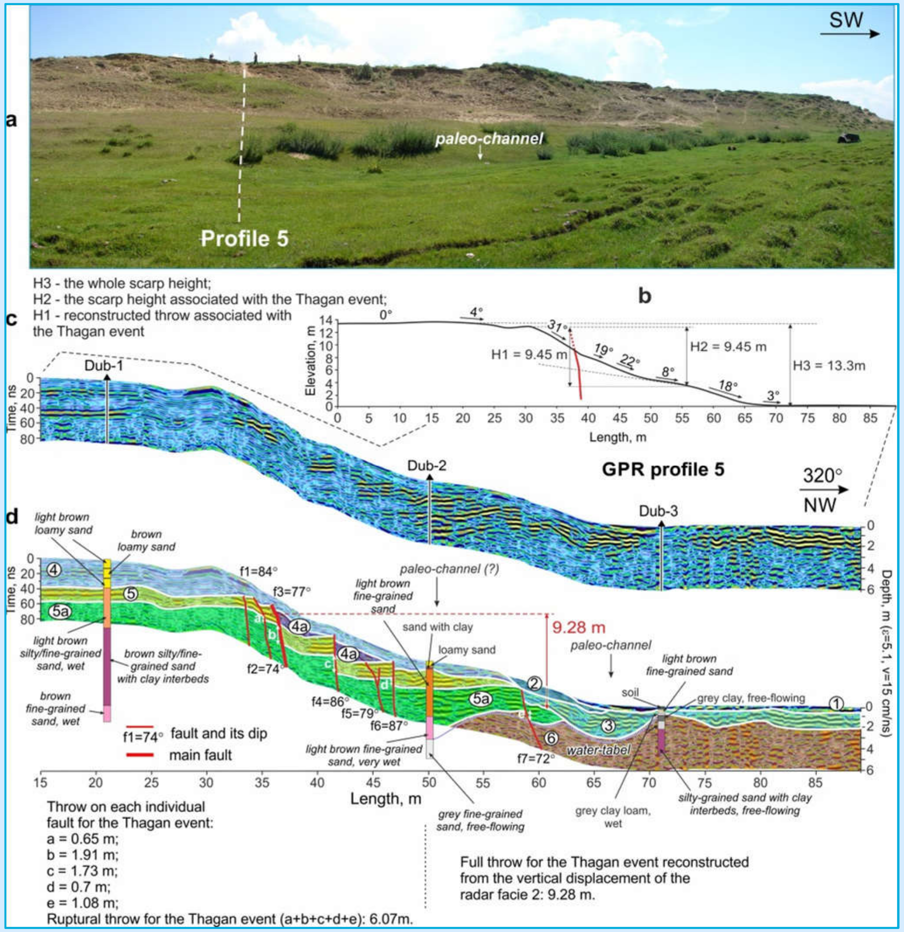
Besides, we considered a number of other parameters in relation with the value of the last single-event offset in the upper sedimentary layer at a depth of the first meters.

As a result, it was found that the displacement during the Tsagan earthquake occurred under NW-SE extension as motion on a stepped system of normal faults with a dip of the major plane to the NW at angles 56–77°. The total throws from GPR data on each of seven profiles were 3.83 m, 9.59 m, 2.4 m, 4.27 m, 9.28 m, 6.6 m, and 1.81 m, which are aligned with vertical fault displacements H1 with an error from 0.03 to 0.47 m. H1 was defined as a vertical distance between the intersections of the fault plane, and planes formed by the displaced original geomorphic surfaces (McCalpin, 2009). The brittle components were 2.32 m, 5.54 m, 1.93 m, 3.0 m, 6.07 m, 4.2 m and 1.58 m, respectively. The contribution of the ductile component to the total displacement varies from 13% to 42%, the visible fault damage zone widths are from 2.55 m to 20 m. The maximal contributions of the ductile component correspond to minimal fault dips of the major fault plane and, as a whole, to the largest fault damage zone widths, which also correlate well with the offset values (see on the slide 5).



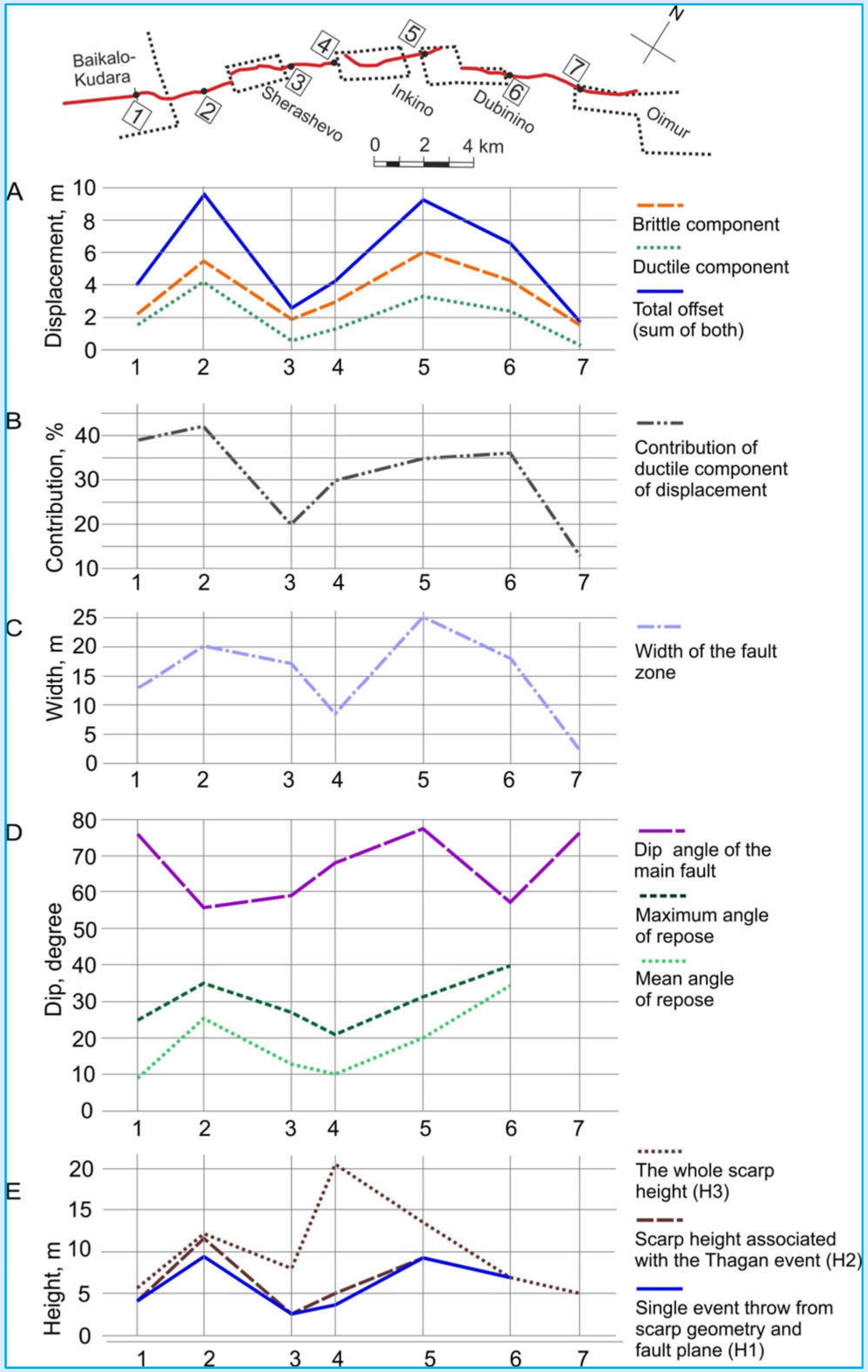
A view of site with locations of **GPR profile 1 (as an example)** across the Delta fault scarp (a); typical sedimentary section close to profile (b); topographic profile (c), GPR profile (d), and its interpretation (e) with inferred ruptures, displace-ments (in meters), and radar facies (numbers in circles) corresponding to layers of different dielectric properties





Views of sites with locations of **GPR profile 4 and 5 (as examples)** across the Delta fault scarp (a); topographic profiles (b), GPR profiles (c), and their interpretation (d) with inferred ruptures, displacements (in meters), and radar facies (numbers in circles) corresponding to layers of different dielectric properties

Distribution of fault zone characteristics inferred from geomorphological and ground-penetrating radar data →



Concluding remark:

The structural features of the rupture zone and peculiarities of throw distribution in unconsolidated sediments should be taken into account in order to avoid underestimating the magnitudes of the normal fault earthquakes and their seismic effect. In the case of soft sediments of mixed rheology (competent and incompetent), obviously, one should expect large values of total displacements and wider zones of deformations, in comparison with homogeneous sections.

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THANK YOU FOR READING AND FEEDBACK!