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Geomorphology of submerged river channels indicates Late Quaternary tectonic activity in the Gulf of Trieste, Northern Adriatic

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We use multibeam and parametric subbottom sonar data, complemented with multichannel and high-resolution single-channel seismic profiles, to investigate sea-bottom morphology and subbottom sediment structure in the south-eastern half of the Gulf of Trieste, northern Adriatic Sea. The study area comprises 180 km2 of predominantly flat seabed with the water depth from 20 to 25 m.

Pre-Quaternary basement consists of Mesozoic-Paleogene carbonate platform unit, overlain by Eocene marls and sandstones, covered by up to 300 m thick Quaternary sediments of predominantly continental origin. The uppermost few meters of sediment consist of Holocene fine-grained marine deposits. Structurally, the investigated area belongs to the imbricated rim of the Adriatic microplate and is dissected by several NE-dipping low-angle thrusts with up to several kms of displacement. The thrusts are cut by younger NE-SW-trending steeply dipping faults with sinistral and/or normal offset, mapped onshore. The continuation of those faults into the offshore area is suggested by mismatch of thrust structures between parallel seismic profiles. Geodetic data on present-day tectonic activity is controversial. Whereas the Adriatic microplate is currently moving northwards towards Eurasia at the rate of 2-4 mm/yr, the GNSS data show no measurable deformation in the Gulf of Trieste. On the other hand, onshore precise-levelling data suggest localized vertical motions in the range of 1 mm/yr, interpreted as an indication of thrust activity.

High-resolution swath bathymetry revealed several current-related erosional and depositional features such as gullies and megadunes with up to 5 m of relief. The most conspicuous seabed morphological features are pre-Holocene river channels preserved in low-erosion submarine environment, which make excellent markers for studying the long-term geomorphological evolution of the area.

The WNW-ESE-trending paleo-Rižana river is characterized by highly sinuous meandering channels. Sequential profiles perpendicular to the river course suggest consistent ∼NE-ward lateral shifting of channels, parallel with inclination of the present-day seabed and with the present-day lateral gradient in channel depth. A longitudinal profile of the Rižana river plain revealed downstream increase in elevation of the stream bed, visible both from seabed bathymetry and from vertical position of channel lag deposits in subbottom sonar profiles. These observations suggest post-depositional tectonic tilting of the fluvial sediments that could be related either to activation of NE-dipping thrusts in the pre-Quaternary basement, or to minor anticlinal folding associated with Quaternary transpressional faulting along NW-SE-trending zones, implied from seismic profiles NW-ward of our study area.

An enigmatic low-sinuosity channel feature runs along the coastline in the NE-SW direction and crosses the paleo-Rižana channel. Subbottom sonar profiles show asymmetric channel geometry and strong reflectors (channel lag deposits?) at the channel bottom, typical of other documented river channels in the area. This feature is vertically offset by a NE-SW-trending linear morphological flexure that corresponds in location and orientation to the onshore Monte Spaccato fault. Subbottom profiling revealed in several places an abrupt truncation of horizontal reflectors that could be manifestation of faulting.

These indications of Late Quaternary – Holocene tectonic activity may have important implications for seismic hazard in the heavily populated coastal area of the Gulf of Trieste.