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Chasing the next big earthquake in Costa Rica

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The next M~7 could occur within 5 to 10 years

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Subduction zones generate the potentially most catastrophic earthquakes and tsunami in the world. Monitoring megathrust activity, both seismic and aseismic, is critical for improving earthquake hazard assessments. The rapid convergence (85-90 mm/yr) of the Cocos plate underneath the Panama block in southern Costa Rica, produces M7+ earthquakes with an average recurrence interval of 40 years underneath Osa and Burica peninsulas, providing an exceptional opportunity for monitoring and understanding the earthquake cycle.

The last one of these events, a moment magnitude (M_w) 7.3 earthquake, hit the peninsula on the Holy Saturday (April 2) in 1983 at 20:50, local time. Assuming a constant recurrence time, the next big event is expected to occur within the next 5 to 10 years. Because of the advantageous location of the Osa Peninsula, extending seaward over the seismogenic zone and the existence of a regional seismic and continuous Global Positioning System (GPS) network maintained by OVSICORI-UNA, megathrust activity is being recorded with extremely good detail since the last 3 years, making it an ideal locality to study the earthquake cycle. Since the subduction process is dominated by the continuous subduction of topographic highs or sea mounts, frictional heterogeneities along the fault may be responsible for generating aseismic creep or slow slip events, as observed further north along the Nicoya Peninsula, increasing the odds of occurrence of a next big event.

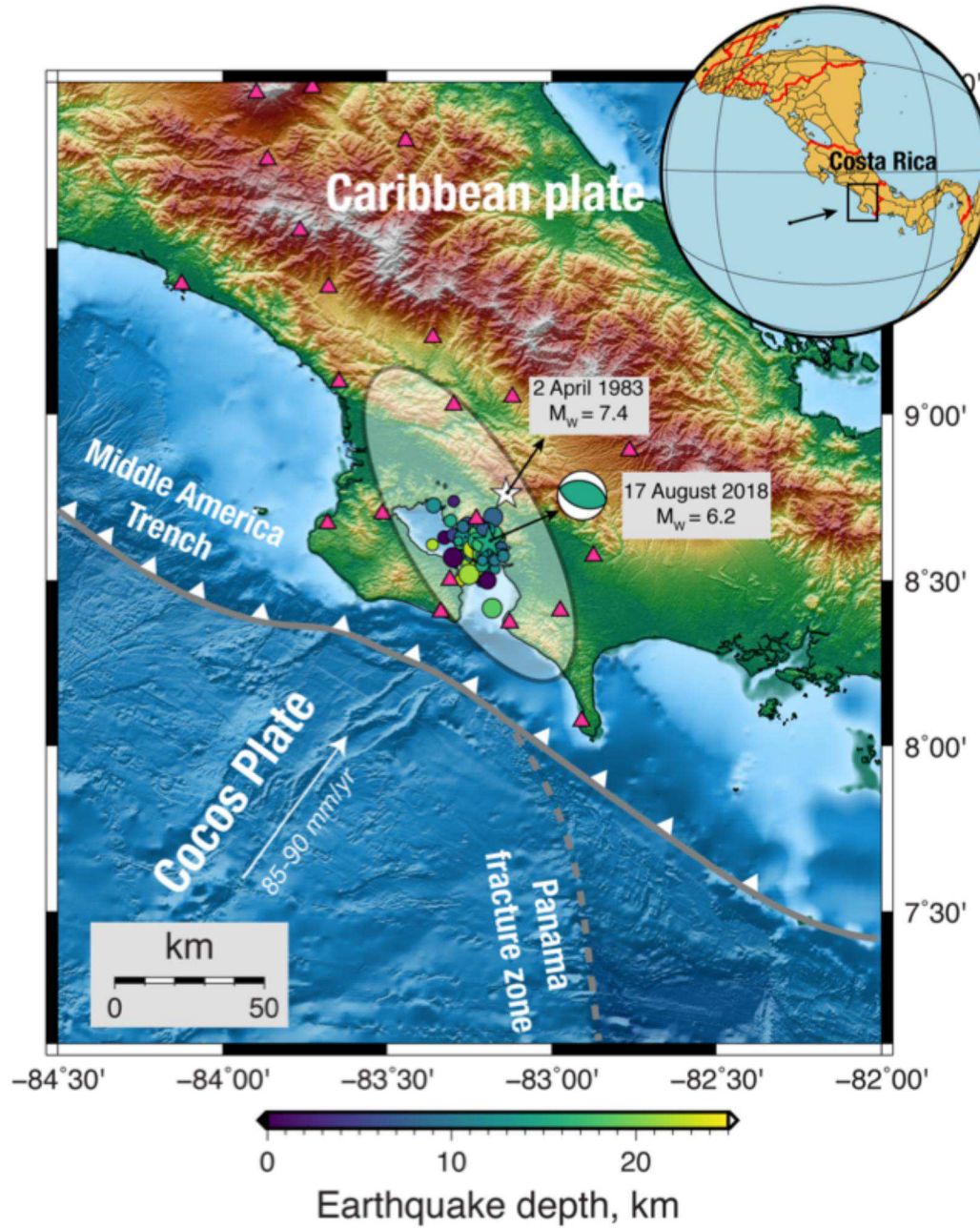


Fig. 1. Tectonic setting and spatial distribution of the aftershock sequence of the 17 August 2018, M6.2 Golfito earthquake. Events are color coded by depth in km. Triangles correspond with broadband seismic stations from OVSCORI-UNA. The white contour and star indicate the slip area of the April 2, 1983 M=7.3 megathrust earthquake (Tajima and Kikuchi, 1995).

A M_W 6.2 earthquake (~100 times less energetic than the expected megathrust event) occurred on Friday, August 17 at 5:22 pm, local time, at 15 km depth (Fig. 1). Although this event was widely felt in the country, it generated little to no damage in areas closer to the earthquake epicenter: Golfito, Puerto Jimenez, Agua Buena and San Vito de Coto Brus. But it raised the alarm of the locals and emergency agencies of the country concerning the potential of the next big temblor. Analysis of the regional full waveform moment tensor inversion confirms a thrust faulting earthquake that locates on the plate interface between the Cocos plate and the Panama block. High frequency (5 Hz) GPS time series recorded at several stations, exhibit up to 10 cm vertical displacement in regions where strong ground motions reach $\sim 200 \text{ cm/s}^2$ (Fig. 2).

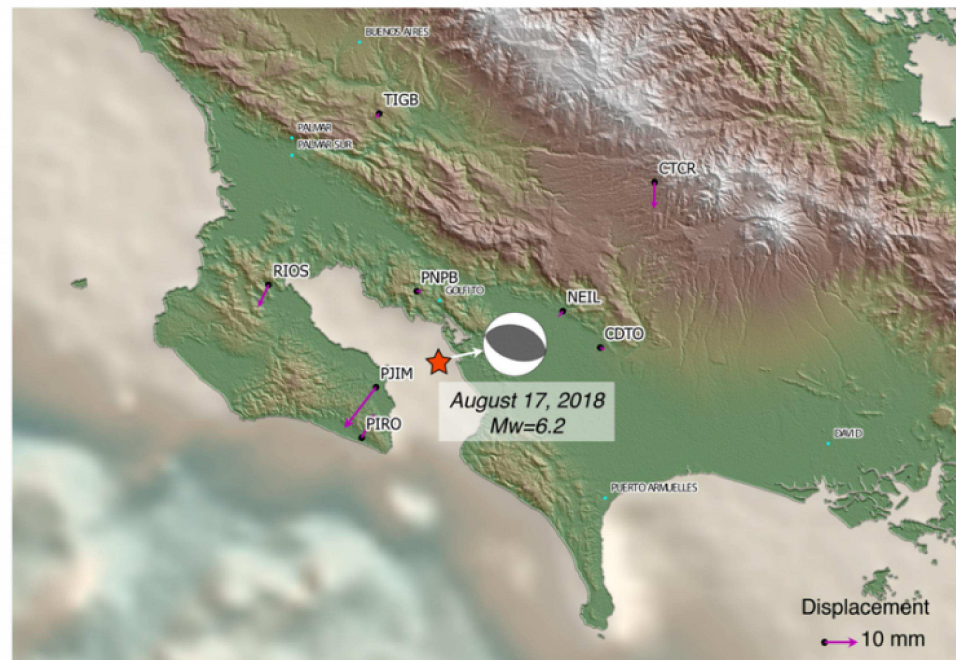


Fig. 2. The map shows the spatial distribution of the continuous GPS stations that recorded the main event on Friday, August 17, with arrows indicating the co-seismic (resultant) displacement in mm.

Several hundreds of aftershocks have been recorded in the seismic stations from OVSICORI-UNA since the occurrence of the mainshock on Friday. Nearly 100 of these events located with local magnitudes between $M=2.0$ – $M=5.2$. The depth exhibited by these events is consistent with

previous work that suggests a shallow dipping interface with depths, under Osa peninsula, between 4 and 6 km, reachable with current drilling techniques. Therefore, this peninsula represents an excellent geographic (and temporal) opportunity to access and instrument a megathrust interface.

References

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