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Do active faults' clay mineral compositions affect whether earthquake ruptures they host will displace the surface?

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The tectonophysical paradigm that earthquake ruptures should not start, or easily propagate into, the shallowest few kilometers of Earth's crust makes it difficult to understand why damaging surface displacements have occurred during historic events. The paradigm is supported by decades of analyses demonstrating that near the surface, most major fault zones are composed of clay minerals – particularly extraordinarily weak smectites – which most laboratory physical measurements suggest should prevent surface rupture if present. Recent studies of New Zealand's Alpine Fault Zone (AFZ) demonstrate smectites are absent from some near surface fault outcrops, which may explain why this fault was able to offset the surface locally in past events. The absence of smectites in places within the AFZ can be attributed to locally exceptionally high geothermal gradients related to circulation of meteoric (surface-derived) water into the fault zone, driven by significant topographic gradients. The record of surface rupture of the AFZ is heterogeneous, and no one has yet systematically examined the distribution of segments devoid of evidence for recent displacement. There are significant implications for seismic hazard, which comprises both surface displacements and ground shaking with intensity related to the area of fault plane that ruptures (which will be reduced if ruptures do not reach the surface). We will present results of new rigorous XRD clay mineral analyses of AFZ principal slip zone gouges that indicate where smectites are present, and consider if these display systematic relationships to surface displacement records. We also plan to apply the same methodology to the Carboneras Fault Zone in Spain, and the infrequent Holocene-active faults in Western Germany.