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A 3 km deep on-fault thermometer array for measuring the heat generated by forthcoming earthquakes in a South African gold mine.

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At one gold mine in South Africa, mining at a depth of 3 km intersects with a major geological fault. Some sections of this fault are expected to slip to cause an M2-3 earthquake as the stress builds up by ongoing mining. At one such site, we drilled seven boreholes into the fault and built a network of 21 precision thermometers to quantify frictional heating by a forthcoming earthquake. Proximity of the sensors to the slip plane is critical because difficulty increases with the cube of the sensor-fault distance d; the magnitude of the temperature rise decreases as 1/d, the time to peak increases as d^2. Although a thick ($\sim$20 m) fault zone is recognized at our site, there seems to be a distinct weak plane of $\sim$10 cm thickness, to which severe damage in each borehole is restricted. This seems to be a continuous structure at least over a 15 m x 7 m extent covered by the fanned-out boreholes. On the tunnel wall, this plane is distinguished as a friable and well-foliated layer, across which a fault displacementmeter has been installed. Many thermometers were placed at $d < 1$m from this seemingly weak plane, betting on it to be the future slip plane. At d = 1 m, temperature is expected to rise by $\sim$10 mC over 10 days following the event, assuming a 2 cm slip and a weak fault of a 20 MPa sliding friction. Such a signal is expected to be detectable, judging from the stability of the temperature data so far recorded, telemetered to the mine's seismic monitoring system, and e-mailed to Japan every hour. Independent constraints on shear and normal stresses on the fault are expected from ongoing observation with an Ishii strainmeter installed at d $\sim$20 m.