Serpentinite Seduction

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Serpentinite, a valued green decorative building stone and the official California state rock, forms through hydrothermal alteration of peridotite, the rock of Earth's mantle. It is common in ophiolites, which are exposed fragments of oceanic crust and subjacent mantle.

It has been assumed that serpentinite is widespread in oceanic plates undergoing subduction (1–3). If true, this would have important implications for earthquake and volcano activity in subduction zones. During subduction, water is released from serpentinites by metamorphic dehydration reactions. It has been suggested that serpentinite provides a particularly fertile water source for magma generated in subduction-related arc volcanoes (4). Furthermore, water released by metamorphic dehydration could trigger subduction-zone earthquakes (4).

In concert with previous studies (2, 3), Dobson et al. contend on page 1407 of this issue (5) that earthquake hypocenters in the lower segments of double seismic zones (see the figure) can be attributed to serpentinite dehydration. Is serpentinite indeed widespread in the subducted oceanic plates, or is it a green her- ring?

In the nonsubducting Atlantic oceanic plate, serpentinite is common where transform faults intersect and offset the slow-spreading Mid-Atlantic Ridge system. Hydrothermal circulation of seawater transforms the shallow peridotites into serpentinite. Seismic data suggest that the serpentinite may be 2 to 3 km thick (6).

In contrast, with rare exceptions (7), serpentinites are virtually nonexistent in the fast-spreading ridges of the Pacific oceanic plate and in ophiolites believed to be associated with fast-spreading centers (8). Nonetheless, serpentinitization of oceanic mantle entering subduction zones around the Pacific (where most of Earth's subduction occurs) has been postulated to arise from infiltration of seawater into transform faults (3) or along deep faults at the "outer rise" where oceanic plates bend upon entering subduction zones (2). The formation of serpentinite in the lower part of double seismic zones would require ingress of seawater to depths of around 50 km (see the figure). It is unlikely, however, that the outer rise faults are open to such depths, or that an interconnected fracture network allows deep

Serpentine hide-and-seek. Plate tectonic model showing where serpentinite (dark green) has been postulated to form. Stars represent earthquake hypocenters. In the subducted plate, the hypocenters outline a double seismic zone. Large purple arrows indicate relative plate motion. Spreading occurs at the mid-ocean ridge (MOR). Blue arrows depict fluid ingress or expulsion. Magma is shown in red. Serpentinite along the transform fault is relevant to the slow-spreading Mid-Atlantic Ridge, whereas the other serpentinite locations are relevant to the Pacific plate.

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References
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Is the Hydrological Cycle Accelerating?

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Early studies of instrumentally detected climate change (1–3) mostly concentrated on the history of measured air temperature. More recent research has investigated the variability of other climatic factors such as irradiance (4, 5), water vapor (6), wind speed (6), and precipitation (7). In interpreting these data sets, researchers were conscious of the recent global warming and the expected consequences of the enhanced greenhouse effect.

One of these expectations was that evaporation would increase under a warmer climate. But in 1995, Peterson et al. reported a decrease in pan evaporation between 1950 and 1990, based on data from the United States and the former Soviet Union (8). The authors used data from a network of pan evaporimeters. These simple instruments consist of a water-filled pan, a device to measure the water needed to return the surface to a predetermined level, and a rain gauge (see the figure). They were first used in the 19th century, but only since 1951 have homogeneous data been available.

Peterson et al. (8) did not distinguish between pan evaporation and terrestrial and potential evaporation (9). They found the decreasing pan evaporation (and hence terrestrial and potential evaporation) to be in phase with the decreasing diurnal temperature range (daily maximum minus minimum temperature), which they related to increasing cloud cover. They thus concluded that evaporation had decreased in a warming climate.

In contrast, Brutsaert and Parlange (10) regarded the pan evaporation as fundamentally different from the terrestrial evaporation. They argued that the decreasing pan evaporation is a signal of increasing terrestrial evaporation, because the latter will cast moist air over a water-filled pan. The decreasing pan evaporation would then be an indication of an increase in the water vapor content of the atmosphere.

In the distant future, a change in global dynamics may cause the Atlantic plate to undergo subduction. I postulate that the large amount of water released by dehydration of the subducted Atlantic oceanic serpentinites will then result in a significant quantity of arc volcanism and a lot of earthquake activity.

References