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Patterns of intraplate volcanism on Earth controlled by asthenospheric shear

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Most of Earth's volcanism occurs at subducting and rifting plate boundaries, and at fewer than a dozen high-volume volcanic fields fed by upwelling plumes from the deep mantle. The remaining intraplate volcanism, which is typically basaltic, low-volume, and effusive, occurs away from plate boundaries on every continent and produces seamounts on the ocean floor. Although it has been attributed to various localized processes such as lithospheric cracking or sub-lithospheric small-scale convection, this effusive volcanism is ultimately driven by Earth's interior heat, which also drives mantle convection. To pursue links to interior convection, we compare intraplate volcanism locations with patterns of global mantle flow from a numerical model. We show, with high statistical confidence, that recent continental and oceanic intraplate volcanism occurs preferentially above rapidly-shearing regions of the asthenosphere. Basaltic volcanic fields in western North America, eastern Australia, southern Europe, and Antarctica exemplify this relationship, as does an area of dense seamount volcanism west of the East Pacific Rise that was more intense during periods of rapid Pacific spreading. These correlations indicate a control on intraplate volcanism from mantle-scale convection, and are most easily explained by the interaction of asthenospheric shear with sub-lithospheric viscosity heterogeneity, which can induce "shear-driven upwelling" and melting.