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# Cascadia Backarc-Forearc Tectonic Links Interpreted from Potential-Field Anomalies, Geologic Mapping, and Paleoseismology

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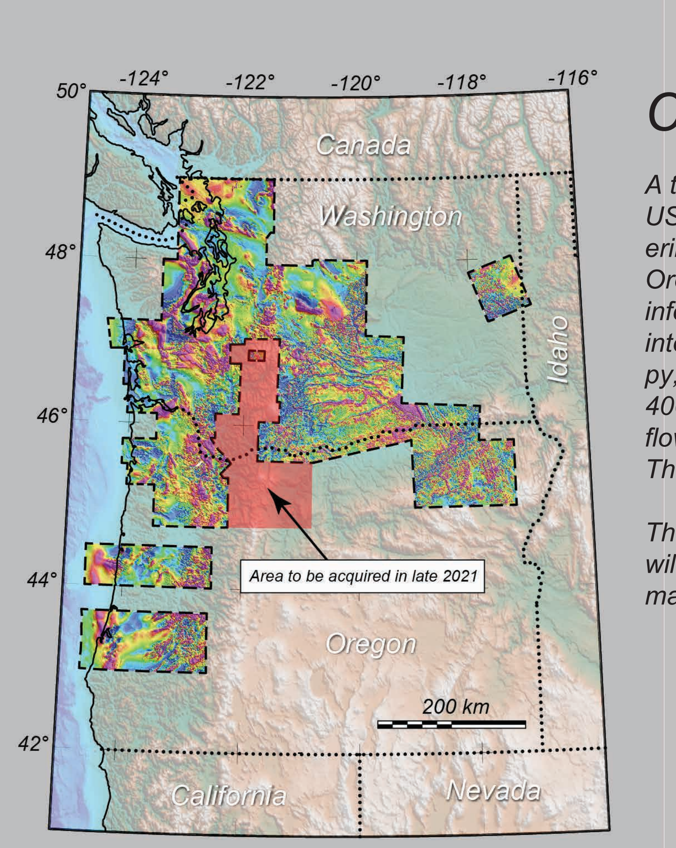
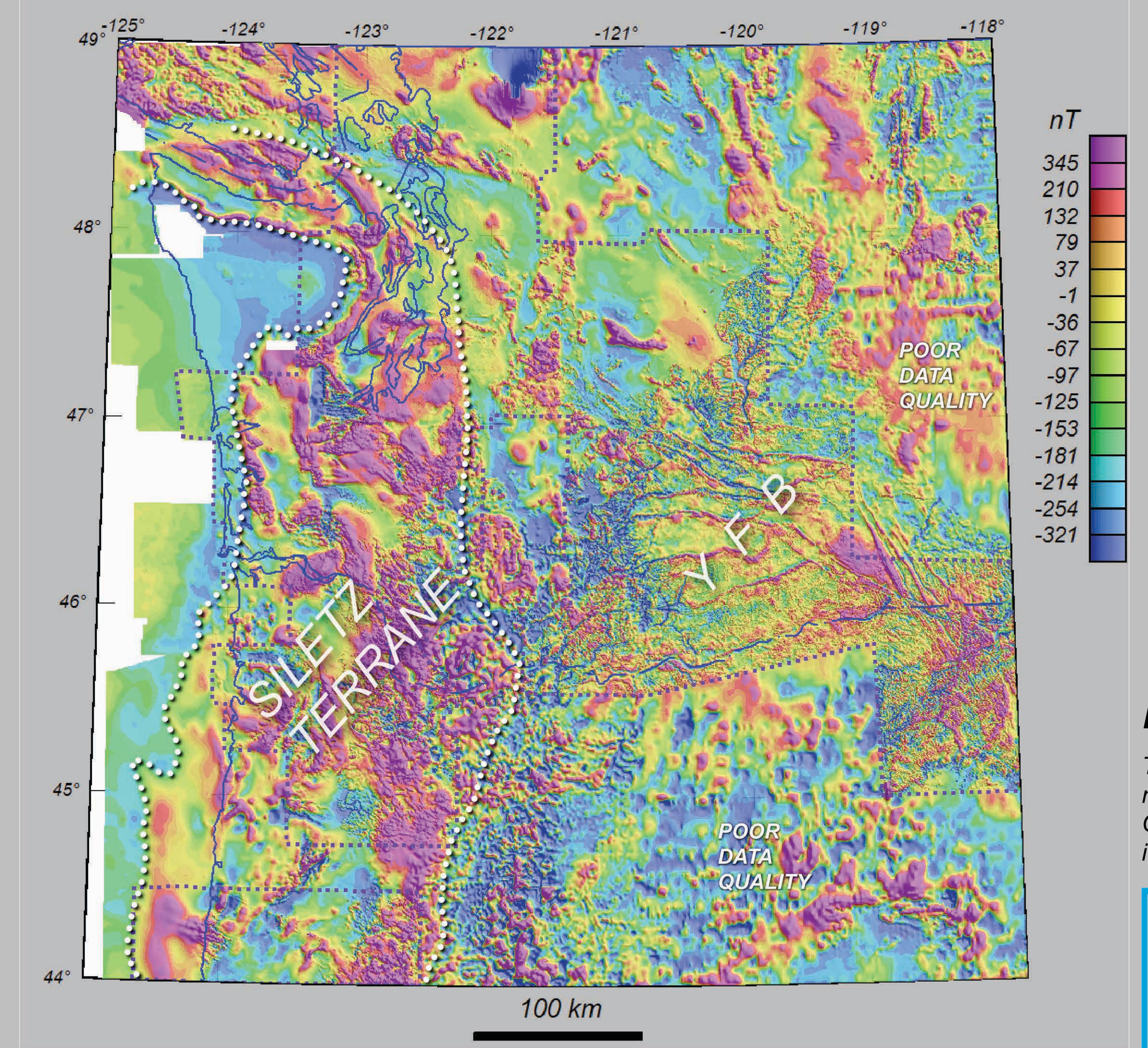



## Cascadia aeromagnetic surveys

A three-decade program of airborne data acquisition by the USGS has provided high-resolution aeromagnetic surveys covering >150,000 km² of the Cascadia forearc and backarc of Oregon and Washington. These data provide a rich tapestry of information about subsurface geology and tectonic history when interpreted in combination with geologic mapping, lidar topography, and other geophysical methods. Most areas were flown at 400-m line spacing and 250-m above terrain. Surveys were flown by various private contractors under contract to the USGS. These data are now published and available online.

The southern Washington and northern Oregon Cascade Range will be flown in late 2021, filling a major gap in high-quality aeromagnetic coverage.

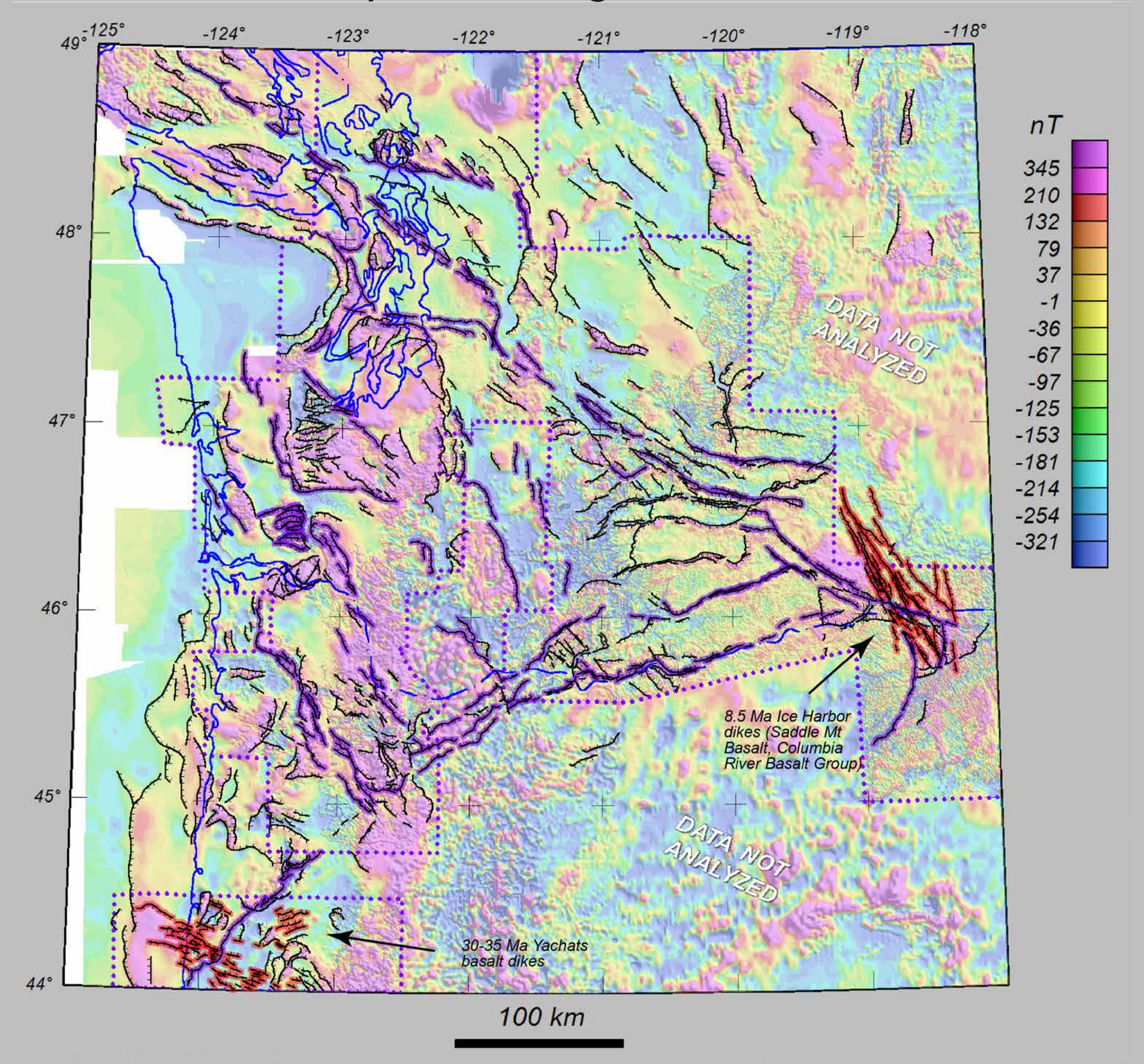
## Cascadia aeromagnetic compilation




We merged our recently acquired high-resolution aeromagnetic surveys to each other and then to older Oregon and Washington statewide compilations (Finn et al., 1989; Roberts et al., 1997). The map above shows these merged surveys reduced to the pole. The purple dotted lines indicate the limits of high-resolution data. High-amplitude anomalies in the Oregon and Washington Coast Ranges are caused in part by Eocene basalts of the Siletz River Volcanics in Oregon and Crescent Formation in Washington, AKA Siletz terrane (white dotted line). East-west linear anomalies in the backarc are related to faults and folds of the Yakima fold belt (YFB).

We are impressed with the pattern of left-stepping linears in magnetic anomalies, some corresponding to active faults, that apparently link Cascadia backarc and forearc structures, as originally proposed by Beeson and Tolan (1990).

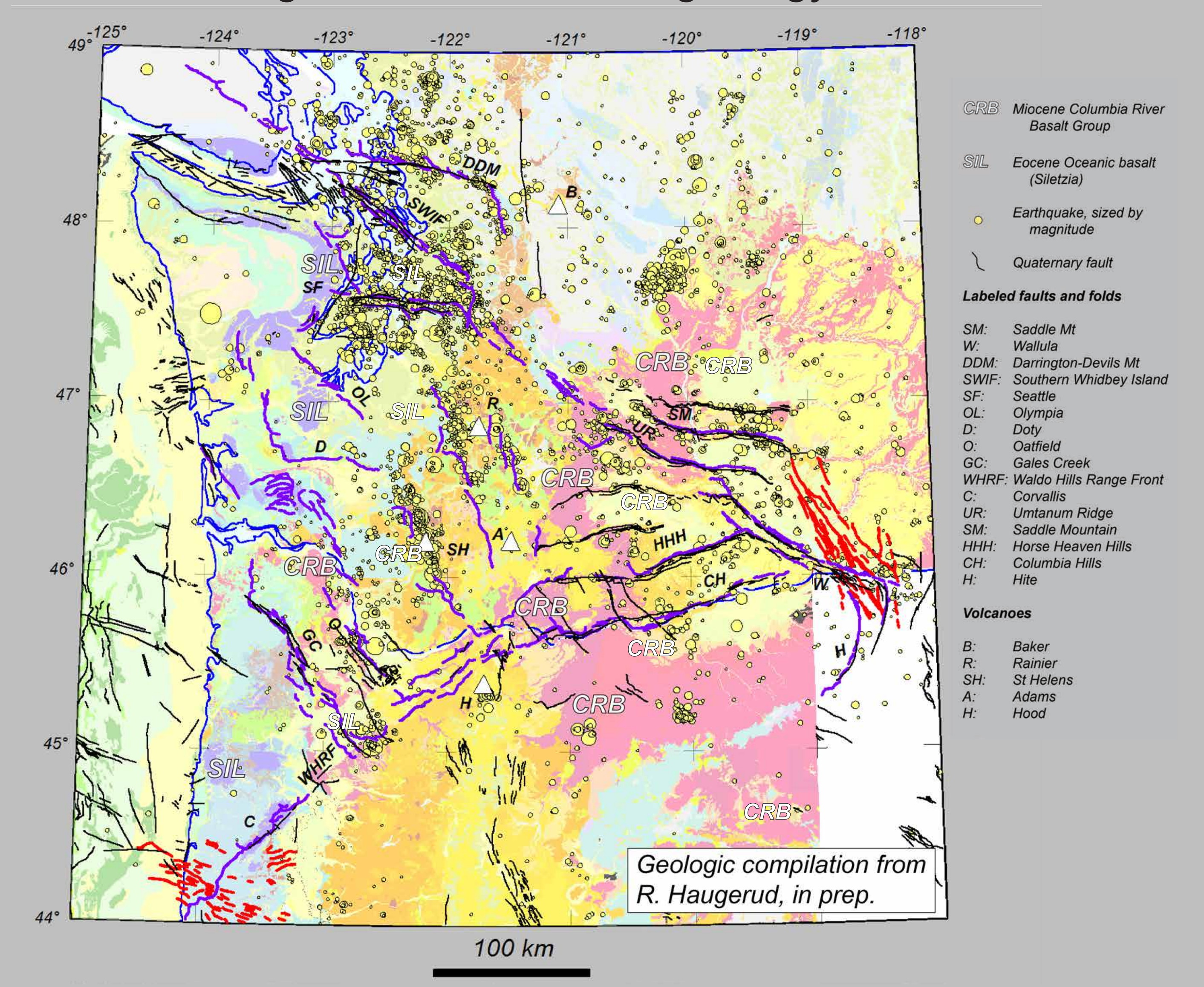
## Interpreted magnetic contacts




The black lines on the map above are interpreted contacts between subsurface rocks of contrasting magnetization, with hachures pointing in the direction of increasing magnetization. Our contact locations were guided by an objective, three-step procedure: (1) transformation to pseudogravity anomalies, (2) calculation of maximum horizontal gradient, and (3) location of maxima. Some magnetic contacts in this area closely trace geologically mapped faults, folds, and dikes. Magnetic contacts thus can be used to identify previously unrecognized structures and extrapolate structures already mapped.

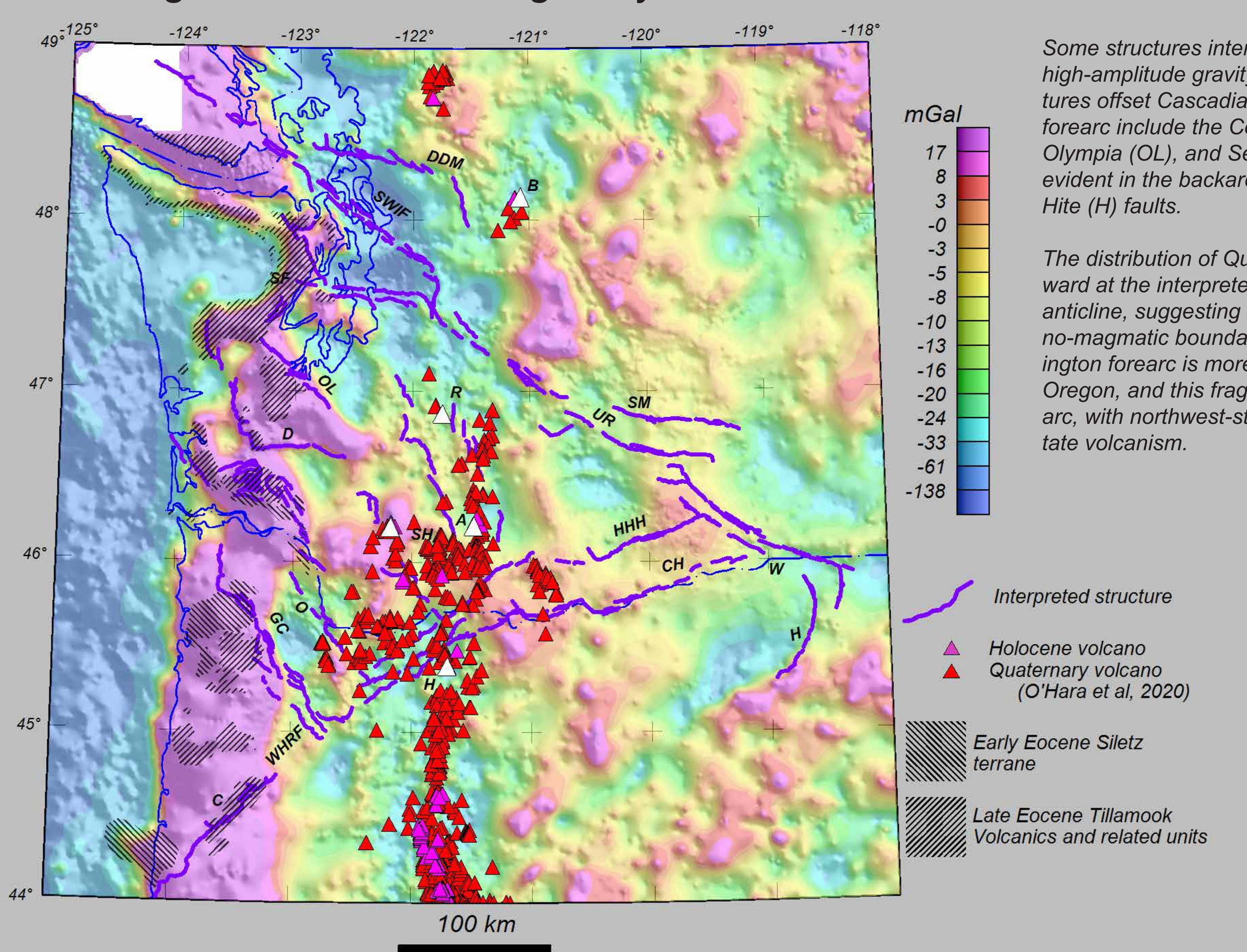
Some magnetic contacts are additionally highlighted with purple and red to identify specific linears germane to our interpretation, repeated in neighboring maps. Purple signifies a fault or fault zone; red indicates a dike or dike zone. Colored lines are repeated on other maps on the poster.

## Magnetic contacts and geology




Previous work used these data to map structural connections between the YFB and active faults and folds in the Puget Lowland (Blakely et al., 2011). Here we focus farther south on similar relations between the YFB and active northwest-striking dextral faults and seismic zones near the Oregon-Washington border. YFB structures that deform Miocene basalts of the Columbia River Basalt Group (CRBG) produce pronounced WSW-striking magnetic anomalies along the fault-bounded Horse Heaven Hills and Columbia Hills anticlines. Interpretive techniques applied to the aeromagnetic data allow us to extend these YFB structures through the Cascade Range and into the Portland and Tualatin forearc basins, where they abut northwest-striking seismic zones (Mt. St. Helens and West Rainier) and active, northwest-striking dextral faults, including the Gales Creek and Portland Hills fault zones. Note that interpreted magnetic contacts lie along most of the northwest-striking faults and seismic zones, and that these northwest-striking structures offset YFB anticlines and thrust faults in the forearc into shorter, east-west oriented structures, a pattern that continues north into Washington (e.g., Grays River, Doty, Rochester, and Seattle fault zones).

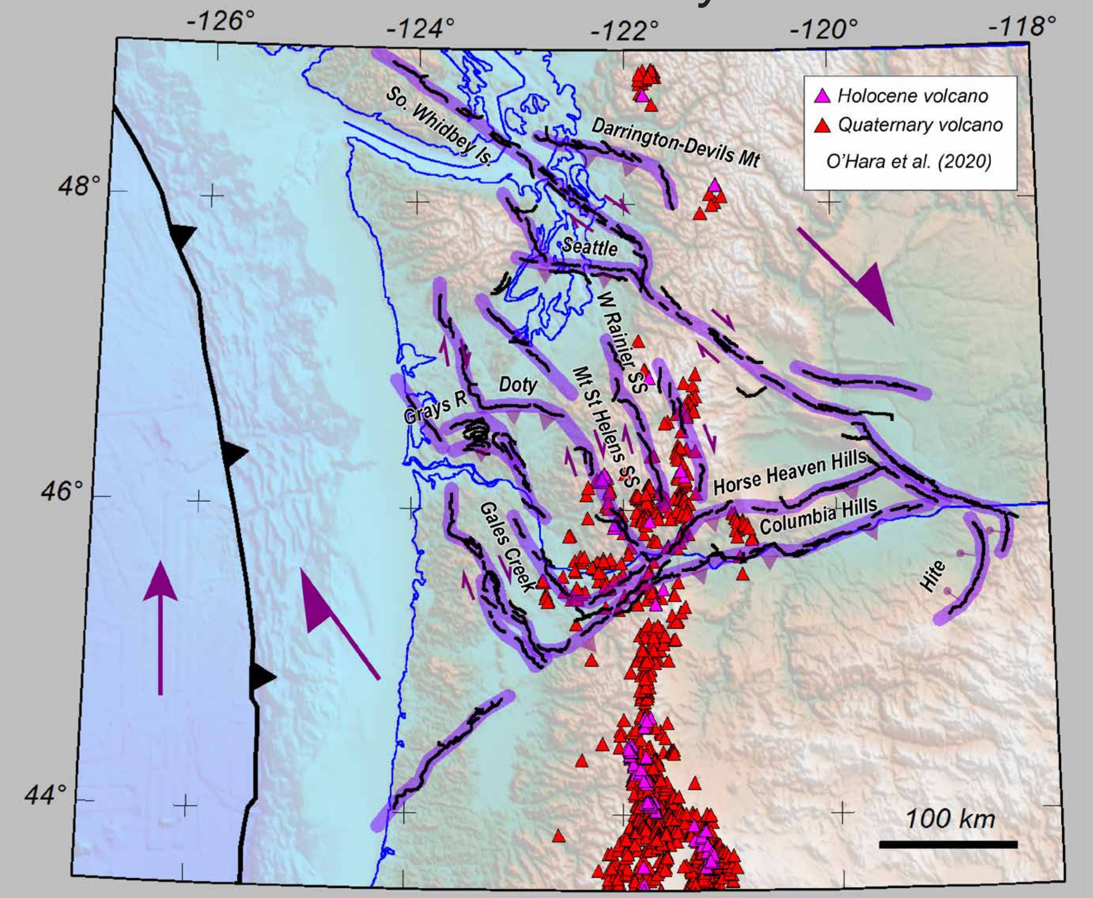
## Magnetic contacts on gravity anomalies




Some structures interpreted from magnetic anomalies cause high-amplitude gravity anomalies, suggesting that these structures offset Cascade basement rocks. Notable examples in the forearc include the Corvallis (C), Gales Creek (GC), Doty (D), Olympia (OL), and Seattle (SF) faults. Similar relationships are evident in the backarc: Umtanum Ridge (UR), Wallula (W), and Hite (H) faults.

The distribution of Quaternary volcanism narrows sharply southward at the interpreted westward extension of the Columbia Hills anticline, suggesting that this structure is an important tectono-magmatic boundary. Gravity anomalies show that the Washington forearc is more fragmented north of this boundary than in Oregon, and this fragmentation may continue eastward into the arc, with northwest-striking transtensional structures that facilitate volcanism.

## Summary




Analysis of aeromagnetic anomalies allows us to extend YFB structures through the Cascade Range and into the Cascadia forearc. The resulting pattern of left-stepping, restraining bends is consistent with observed westward-increasing northward motion of Oregon and Washington.

Dextral slip may be pervasive in the forearc and arc, given ~9 km of right-lateral offset of Miocene Columbia River basalt recently documented on the Gales Creek fault (Wells et al., 2020).

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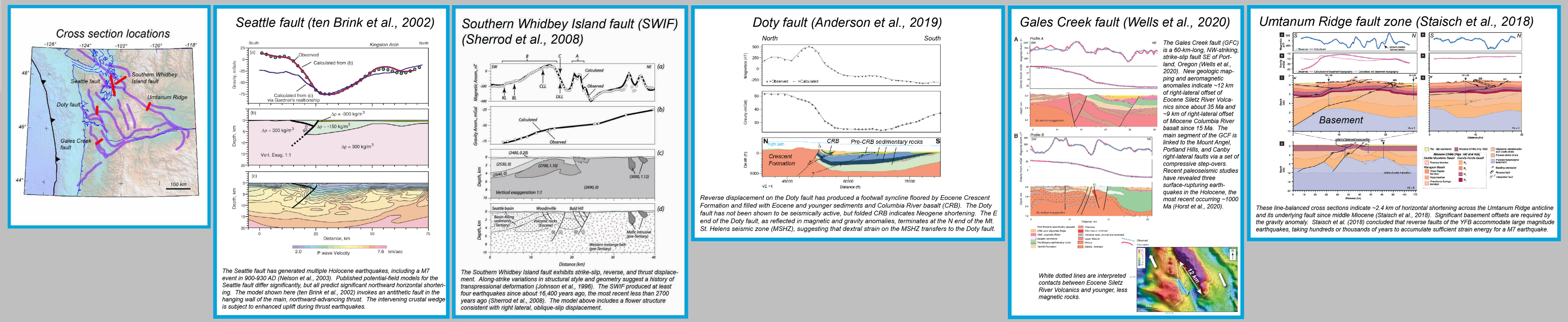
In late 2021, The USGS will conduct a large-scale, high-resolution aeromagnetic survey of the Columbia River Gorge and surrounding parts of the Cascade Range to further support ongoing geologic mapping and constrain back-arc-forearc linkages. See initial map on this poster for survey location.

## Potential-field models across Cascadia faults

The cross sections below were modeled by various researchers using gravity and magnetic anomalies, constrained with geologic mapping and, in some cases, seismic-reflection data. The five sections represent important parts of our model: thrust faults in the Cascadia backarc (Umtanum Ridge), reverse faults in the forearc (Seattle and Doty faults), and dextral transpressive faults that facilitate transfer of strain through the Cascadia arc (Southern Whidbey Island and Gales Creek faults).

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