

# Ice retreat timing and bedrock erosion of the Puget Lobe of the Cordilleran ice sheet

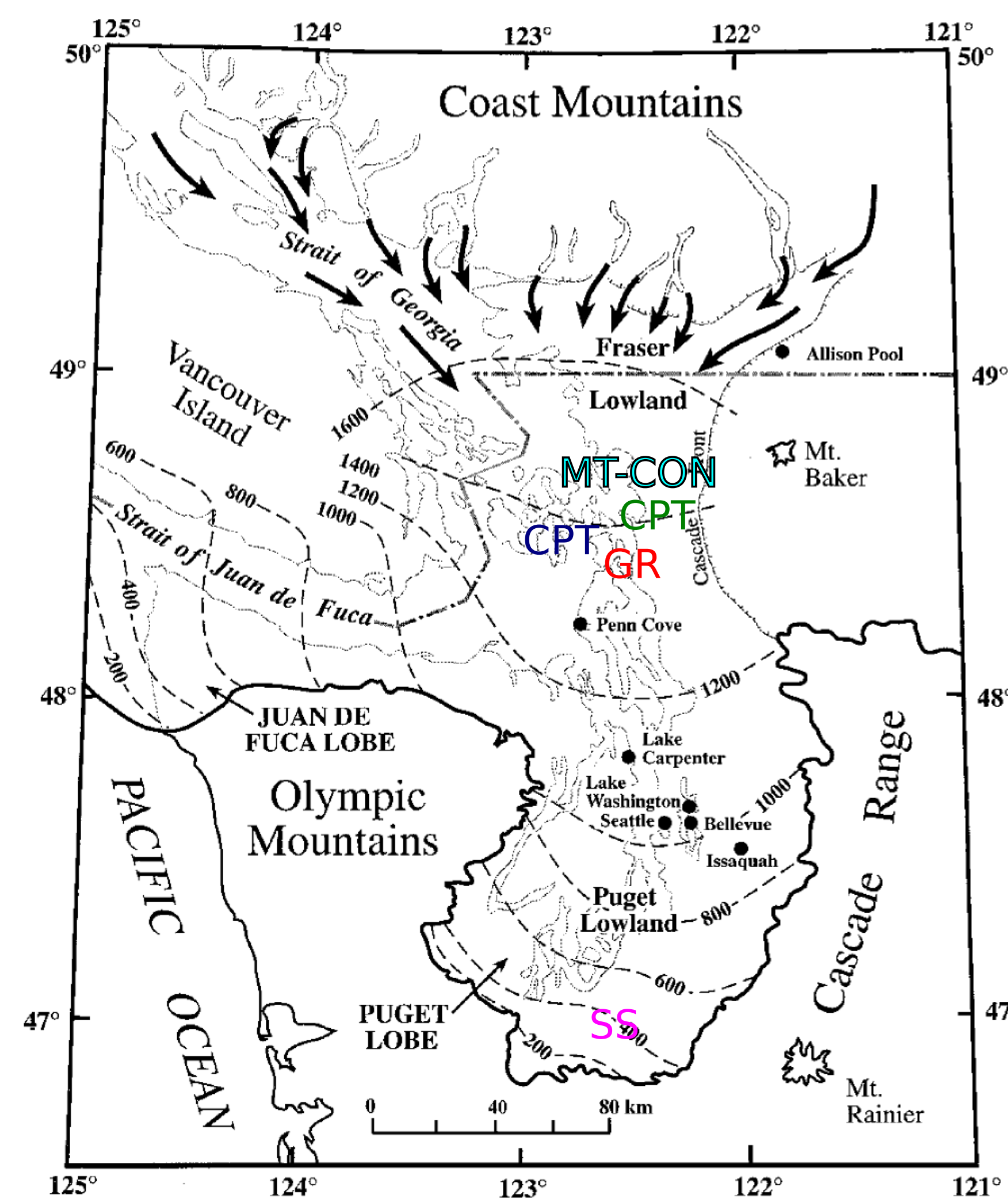
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## Overview

During the Frasier glaciation, ice from the Cordilleran ice sheet flowed south from Canada across the San Juan Islands and into the Puget Lowland. This ice lobe, known as the Puget Lobe, reached its maximum extent in the Puget Lowland 16.95 cal. ka ago (Porter and Swanson, 1998), and began to retreat within a few hundred years.

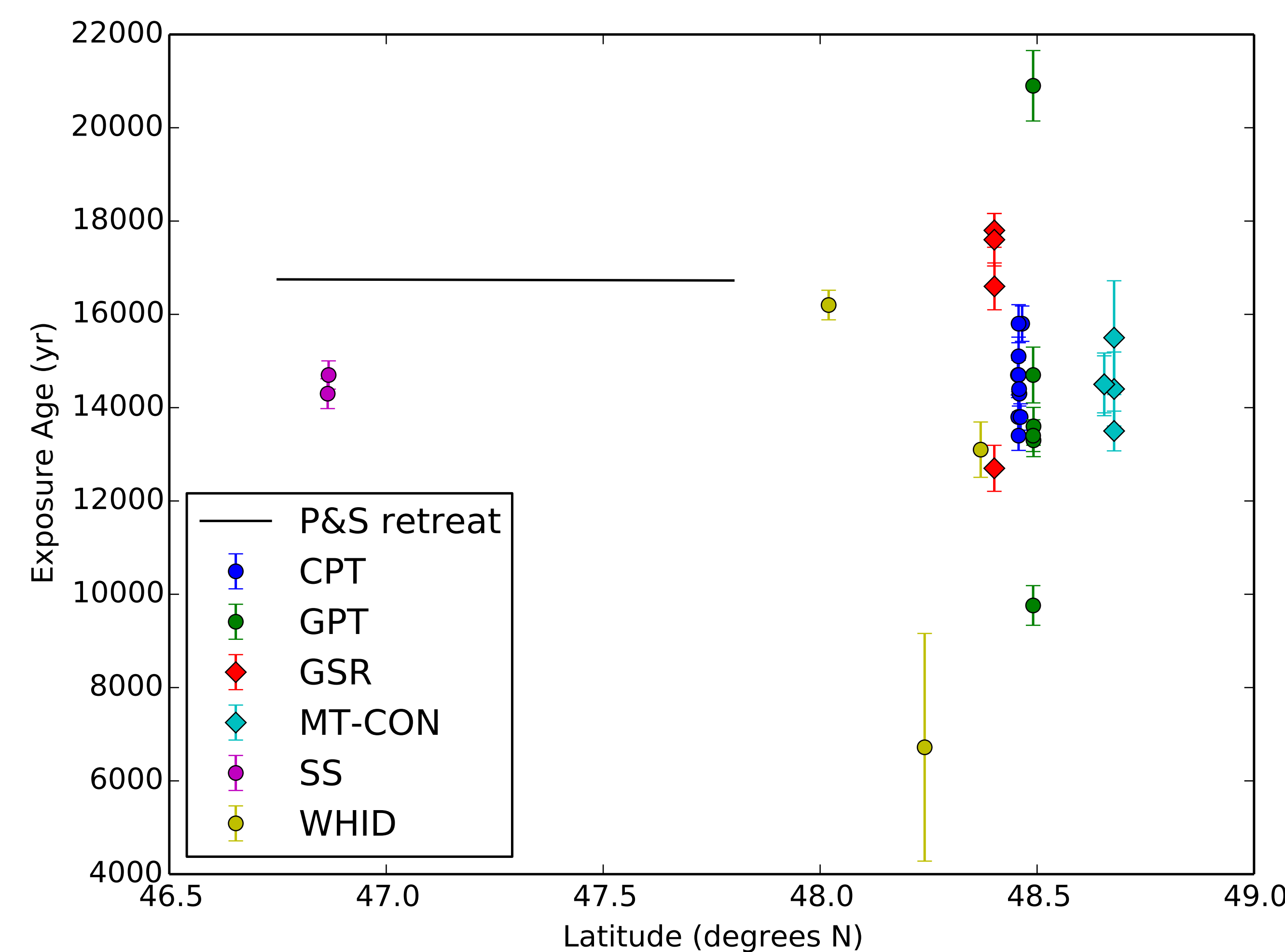


Puget Lobe maximum extent (Porter and Swanson, 1998).

## Methods

- ▶ We collected and measured cosmic ray-produced  $^{10}\text{Be}$  in glacial erratics and glacially eroded bedrock samples from the Puget Lowland and the San Juan Islands.
- ▶ Measured  $^{10}\text{Be}$  concentrations in these rocks can be used to calculate exposure ages, and in the case of bedrock samples, infer the extent of erosion by glacial ice.
- ▶ We compare the  $^{10}\text{Be}$  chronology to existing  $^{14}\text{C}$  dates from the Puget Lowland (Porter and Swanson, 1998).
- ▶ Analyses predating the existing  $^{14}\text{C}$  chronology are instances of limited erosion, resulting in anomalously high concentrations and apparent exposure ages.
- ▶ Reduced apparent exposure ages indicate shielding due to isostatic rebound, soil, sediment or tree cover.
- ▶ Dates calculated using CRONUS Calculator 2.2 (Balco) with production rate from the UW-Scotland-CRONUS calibration data set.

## Apparent exposure ages



- ▶ Black line shows radiocarbon-constrained retreat margin from Porter and Swanson (1998).
- ▶ Bedrock data are plotted as diamonds.
- ▶ All data above P&S retreat curve must have been exposed to cosmic radiation during the previous interglacial period.

## Goose Rock (GR)

- ▶ Bedrock samples from Goose Rock, north end of Whidbey Island, yield apparent exposure ages older than downstream radiocarbon dates, which would require limited glacial erosion (likely  $< 2$  m) of the landform during the last glaciation.
- ▶ Two overprinted sets of glacial striations preserved at Goose Rock may be related to a brief re-advance of the ice sheet after calving retreat when it became grounded at Penn Cove, central Whidbey Island.
- ▶ Further exposure dating of erratic boulders or radiocarbon dates from Penn Cove are needed to test this hypothesis.

## Mt. Constitution (MT-CON)

Bedrock samples collected further north, on Mt. Constitution, eastern Orcas Island, showed no prior exposure in a 5-sample north-south transect across the mountain. Exposure ages are consistent with an ice-free Mt. Constitution by 14.5 ka. This postdates radiocarbon dates from Lake Carpenter and is consistent with upper limiting terrestrial  $^{14}\text{C}$  dates of 14.1 cal. ka on the Sumas I drift located upstream in the Frasier Lowland (Kovanen 2002).

## South Sound (SS) forest shielding

- ▶ Large glacial erratic boulders in the southern Puget Lowland, near the ice sheet terminus, greatly underestimate the true exposure age, possibly due to heavy shielding from cosmic radiation in thick forest (Bretz, 1913).
- ▶ With independent age constraints, cosmogenic isotope measurements from these samples could be used to estimate forest canopy biomass following deglaciation.
- ▶ Southern Puget Sound samples have apparent exposure ages that underestimate the true deglaciation age by 8%, which is comparable to the  $7 \pm 2\%$  shielding factor calculated for dense Olympia forest by Plug et al. (2007).

## Conclusions

- ▶ Shielding of south Sound samples is consistent with forest comparable to the Olympic rainforest at the samples sites prior to western settlement.
- ▶ Ice retreated north of the San Juan islands by 14.5 ka.
- ▶ Exposure of bedrock at Goose Rock, northern Whidbey Island, has not been significantly eroded for two or more interglacial periods.

## References

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- ▶ Bretz, J.H., 1913. Glaciation of the Puget Sound Region. *Washington Geol. Survey Bull.* 8, 244 pp.
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- ▶ Porter, S.C., Swanson, T.W., 1998. Radiocarbon Age Constraints on Rates of Advance and Retreat of the Puget Lobe of the Cordilleran Ice Sheet during the Last Glaciation. *Quat. Res.* 50, 205–213.
- ▶ Plug, L.J., Gosse, J.C., McIntosh, J.J., Bigley, R., 2007. Attenuation of cosmic ray flux in temperate forest. *J. Geophys. Res.* 112, F02022.

## Code and Data Repository

[github.com/zploskey/puget\\_lobe\\_amqua\\_2014\\_poster](https://github.com/zploskey/puget_lobe_amqua_2014_poster)