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### **GSA Data Repository Item 2018144**

Data Repository Information for: Provenance and metamorphism of the Swakane Gneiss: Implications for incorporation of sediment into the deep levels of the North Cascades continental magmatic arc, Washington

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### **File DR1: Detailed description of U-Pb and Hf-isotope results from each sample**

#### **Chelan block**

Sample SK15-75 is a garnet–biotite gneiss that was collected just below the Dinkelman décollement and represents the structurally highest exposure of the Swakane Gneiss in the Chelan block (Figure 3). Zircons yield Mesozoic peaks at ca. 74 (n = 26), 86 (n = 11), 92 (n = 12), 144 (n = 6), and 204 (n = 5) Ma. Proterozoic zircons form a tight cluster around ca. 1380 Ma (n = 16) and a spread between ca. 1860–1597 Ma (n = 26) with a small cluster at ca. 1698 Ma (n = 6). Thin, CL-bright rims have dates between ca. 77–65 Ma (n = 4) and are observed on ca. 1737–192 Ma cores. Two oscillatory-zoned rims have dates of ca. 80 and 86 Ma and are observed on Proterozoic cores. The Hf results show a general increase to more radiogenic values with increasing age for the Cretaceous to Jurassic zircons: 1) < 80 Ma zircons have  $\epsilon_{\text{Hf}}$  values

between -10.8 and -40.4 (n = 4); 2) ca. 100–80 Ma zircons are between +12.6 to -12.0 (n = 5), and 3) Early Cretaceous and Jurassic zircons (ca. 152–115) have  $\epsilon_{\text{Hf}}^{\text{fi}}$  values that range from +12.5 to +6.8 (n = 4). Proterozoic zircons from both populations have similar Hf-isotope compositions between +12.0 to -2.3 (n = 7).

Sillimanite–biotite–garnet gneiss SK15-73 was collected from the SW-3B sample locality of Matzel et al. (2004) and represents the structurally deepest exposed level of the Chelan block (Figure 3). Zircon dates reveal a large peak at ca. 73 Ma (n = 29). Tightly spaced populations are observed at ca. 84 (n = 12), 94 (n = 7) and 104 Ma (n = 7). Small Jurassic populations are centered on ca. 153 (n = 5) and 190 Ma (n = 4). Proterozoic zircons cluster around ca. 1380 Ma (n = 8) and between ca. 1779–1643 Ma (n = 18). Multiple thick (~40  $\mu\text{m}$ ), oscillatory-zoned rims have ca. 84 Ma dates, one is located on a ca. 1676 Ma core and the other core was not dated. The ca. 76–71 (n = 3) rims have dominantly flat or ghost CL-textures; the cores of these grains were either too cracked, small, or metamict to analyze. Zircons with dates younger than ca. 78 Ma have  $\epsilon_{\text{Hf}}^{\text{fi}}$  values between -14.4 and -17.5 (n = 5). In comparison, analyses for ca. 100–78 Ma zircons have a larger range of  $\epsilon_{\text{Hf}}^{\text{fi}}$  values between +7.6 to -10.9 (n = 5), and ca. 100–170 Ma zircons are between  $\epsilon_{\text{Hf}}^{\text{fi}} = +10.3$  and +6.5 (n = 4). Four Proterozoic zircons have  $\epsilon_{\text{Hf}}^{\text{fi}}$  values between +2.5 to +1.6.

### **Wenatchee block**

Garnet–biotite gneiss KG-100B was collected in the northern portion of the Swakane Gneiss in the Wenatchee block (Figure 3). Zircons yield Mesozoic dates that form closely spaced Cretaceous peaks at ca. 75 (n = 7), 78 (n = 8), 89 (n = 15), 92 Ma (n = 13) and Jurassic peaks at 147 (n = 7), 161 (n = 7), and 210 Ma (n = 3). Proterozoic zircons cluster around ca. 1380 Ma (n

= 11), between ca. 1447–1440 Ma (n = 6), or are scattered between 1589–1828 Ma (n = 25). Zircon rims have dates between ca. 91–72 Ma (n = 7), and the youngest zircons from this population (ca. 77–74 Ma) have  $\epsilon_{\text{Hf}}^{\text{zr}}$  values between +13.0 to +10.9 (n = 5). In comparison, zircons with dates between ca. 99–88 Ma have  $\epsilon_{\text{Hf}}^{\text{zr}} = +11.3$  to  $-13.1$  (n = 6). Other analyzed Mesozoic zircons (ca. 213–102 Ma) have  $\epsilon_{\text{Hf}}^{\text{zr}}$  values between +12.2 to +7.2 (n = 7). Zircons with ca. 1446–1370 Ma dates have initial Hf-isotope compositions between +6.0 and -1.2 (n = 4). In addition, one ca. 1647 Ma zircon has  $\epsilon_{\text{Hf}}^{\text{zr}} = +2.9$ , and one ca. 1779 Ma zircon has an  $\epsilon_{\text{Hf}}^{\text{zr}} = +8.1$ .

Garnet–biotite gneiss SK15-31A was collected near Pass No Pass in the northwest corner of the main Wenatchee block Swakane Gneiss (Figure 3). Zircon dates have three Late Cretaceous peaks at ca. 77 Ma (n = 11), 86 Ma (n = 7), and 92 Ma (n = 13). Older Mesozoic peaks include a small peak at ca. 124 Ma (n = 5) and two closely spaced clusters at ca. 156 Ma (n = 12) and 166 Ma (n = 5). Proterozoic dates form a cluster at ca. 1380 Ma (n = 11) and scattered dates between 1801–1674 Ma (n = 19). Zircons within the ca. 77 Ma peak are all either oscillatory or sector-zoned cores. Two zircons from the youngest ca. 77 Ma population have  $\epsilon_{\text{Hf}}^{\text{zr}}$  values of +1.5 and +0.5, whereas ca. 93–82 Ma zircons have Hf-isotope compositions that cover a wider range from +12.4 to -3.5 (n = 7). Early Cretaceous to Middle Jurassic (ca. 165–115 Ma) zircons have  $\epsilon_{\text{Hf}}^{\text{zr}}$  values between +12.2 to +6.8 (n = 4). One Paleozoic grain (ca. 626 Ma) has an  $\epsilon_{\text{Hf}}^{\text{zr}} = +1.5$ . Grains with dates between ca. 1360–1460 Ma have  $\epsilon_{\text{Hf}}^{\text{zr}} = +10.0$  to +0.8 (n = 3), whereas ca. 1793–1760 Ma zircons have values between +1.5 to -2 (n = 3).

Biotite–garnet gneiss SK14-43B was collected on the southern slopes of Red Mountain in the northern Wenatchee block (Figure 3). Peaks are centered at ca. 78 (n = 7), 82 (n = 6), 95 (n = 5), and 103 Ma (n = 6), and small Jurassic populations are present. Proterozoic zircons include dates between ca. 1459–1362 Ma (n = 23) and ca. 1863–1605 Ma (n = 57) with two main clusters at ca.

1702 Ma (n = 13) and 1727 Ma (n = 11). Three rim analyses yield ca. 76 Ma dates, whereas thicker, mantle zones have dates between ca. 83–81 Ma (n = 3). An increase in U/Th values to ~150 coincides with the ca. 78 Ma population. Three ca. 77–76 Ma zircons have  $\epsilon_{\text{Hf}}^{\text{zr}}$  values between -2.6 to -18.8; one ca. 79 Ma grain has an  $\epsilon_{\text{Hf}}^{\text{zr}} = +11.9$ . Other Late Cretaceous grains (ca. 105–80 Ma) dominantly have  $\epsilon_{\text{Hf}}^{\text{zr}}$  values that range from -0.1 to -7.8 (n = 8) except for three more positive results at +13.0 (ca. 94 Ma), +9.7 (ca. 98 Ma), and +8.5 (ca. 104 Ma). Zircons with dates between ca. 207–153 Ma yield initial Hf-isotope compositions between +11.4 to +9.5 (n = 6). Two Paleozoic zircons have  $\epsilon_{\text{Hf}}^{\text{zr}}$  of +7.4 (ca. 363 Ma) and -2.7 (ca. 487 Ma). Proterozoic zircons have  $\epsilon_{\text{Hf}}^{\text{zr}}$  values of +4.2 and +6.5 for ca. 1379 and 1410 Ma grains, respectively, and +8.3 to -4.5 for ca. 1862–1646 Ma (n = 10) zircons, with one outlier at -15.2 (ca. 1784 Ma).

Biotite–muscovite gneiss SK14-40C was collected ~400 meters to the east of SK14-43B (Figure 3). Zircons reveal Mesozoic dates that form peaks at ca. 78 (n = 7), 86 (n = 11), and 92 Ma (n = 6). Dates that fall between ca. 200–100 Ma are scattered and do not form significant peaks. Proterozoic peaks include a sharp ca. 1380 Ma (n = 16) peak and a broader distribution of dates between ca. 1872–1600 Ma (n = 20) that consist of two main populations at ca. 1679 Ma (n = 6) and ca. 1718 Ma (n = 10). Two unzoned outermost rims yield dates of ca. 68 Ma, and three ca. 78 Ma dates correspond to unzoned or chaotically zoned outer rims. Three analyses of mantle zones yield dates between ca. 86–82 Ma and are found on Proterozoic cores. An increase in U/Th values to > 10 is observed for the youngest analyses. Zircons with dates between ca. 91–67 Ma have  $\epsilon_{\text{Hf}}^{\text{zr}}$  values that range from +3.1 to -12.9 (n = 13). Early Cretaceous zircons have  $\epsilon_{\text{Hf}}^{\text{zr}}$  values between -2.3 to -16.7 (n = 4) for ca. 111–100 Ma zircons and +12.1 to +9.1 (n = 2) for ca. 145–124 Ma grains. Paleozoic zircons (ca. 670–493 Ma) have  $\epsilon_{\text{Hf}}^{\text{zr}}$  values from +6.1 to -0.9 (n = 3). Zircons from the two main Proterozoic populations have a similar range of  $\epsilon_{\text{Hf}}^{\text{zr}}$  values between

+9.8 to +2.1 (n = 14). One ca. 1840 Ma zircon has an  $\epsilon_{\text{Hf}}^{\text{zr}}$  value of -2.5, and a ca. 2414 Ma zircon has  $\epsilon_{\text{Hf}}^{\text{zr}}$  of -2.7.

Garnet–biotite gneiss SK15-61A was collected just to the west of the Entiat Fault near Spider Glacier (Figure 3). Nearly all zircons in this sample have thick (30–40  $\mu\text{m}$ ), unzoned rims. Zircons yielded only Mesozoic peaks centered at ca. 72 (n = 24), 88 (n = 10), 95 (n = 30), 124 (n = 23), and 153 (n = 56). All rim dates are between ca. 78–68 Ma (n = 11) and have elevated U/Th ratios (> 10). The Hf-isotope compositions plot between depleted-mantle and CHUR values. Two ca. 72 Ma zircons have the least radiogenic  $\epsilon_{\text{Hf}}^{\text{zr}}$  values of +3.8 and +2.2. Zircons from the Cretaceous and Jurassic populations (ca. 192–86 Ma) are more radiogenic and have  $\epsilon_{\text{Hf}}^{\text{zr}}$  values between +12.5 to +5.5 (n = 18).

Garnet–biotite gneiss SK14-32 was collected at the south end of Massie Lake in the western Wenatchee block (Figure 3). Zircon dates coalesce into small peaks at ca. 79 (n = 7), 94 (n = 13), 99 (n = 9), 109 (n = 6), 124 Ma (n = 6), 149 (n = 6), and 162 Ma (n = 8), and scattered Triassic dates (n = 8). Proterozoic zircons include a small ca. 1392 Ma population (n = 5) and scattered analyses between ca. 1500–1400 Ma (n = 4) and ca. 1827–1618 Ma (n = 9). Four rim analyses yield slightly discordant mid-Late Cretaceous (ca. 79–73 Ma) dates and are observed on ca. 165–94 Ma cores. Uranium/Th values are typically below 10 for all analyses. The initial Hf-isotope composition of a ca. 77 Ma and a ca. 78 Ma zircon is -4.3 and +6.0, respectively. Zircons with dates between ca. 98–80 Ma are dominantly between  $\epsilon_{\text{Hf}}^{\text{zr}}$  of +12.9 and +4.2 (n = 11) apart from two exceptions of -9.6 (ca. 90 Ma) and -14.7 (ca. 95 Ma). Zircons with dates between ca. 165–100 Ma have  $\epsilon_{\text{Hf}}^{\text{zr}}$  values that range between +13.4 to +2.9 (n = 13). A ca. 170 Ma zircon has an  $\epsilon_{\text{Hf}}^{\text{zr}}$  = -7.7. Three zircons with dates between ca. 351–218 Ma have  $\epsilon_{\text{Hf}}^{\text{zr}}$  values of +13.7 to +8.6.

The two Proterozoic populations have  $\epsilon_{\text{Hf}}^{\text{fi}}$  values between +9.6 to -3.7 (n = 5) for ca. 1433–1296 Ma zircons and +8.2 to +2.7 (n = 4) for ca. 1733–1614 Ma grains.

Garnet–kyanite metapelite SK14-28 was collected along the Buck Creek trail in the northern Wenatchee block (Figure 3), near the location of sample 08NC55 of Gatewood and Stowell (2012). Uranium-Pb dates form peaks at ca. 69 (n = 8), 95 (n = 8), 131 (n = 5), 150 (n = 5), and 163 Ma (n = 7). A sharp increase in U/Th values corresponds with the youngest ca. 74–68 Ma zircon rims (n = 12), and three of these rims yielded  $\epsilon_{\text{Hf}}^{\text{fi}}$  values of +7.3–+6.4. In addition, all of these dates are found on ca. 154–92 Ma cores. Three rims found on ca. 189–147 Ma cores yielded dates between ca. 95–80 Ma. Zircons from Cretaceous and Jurassic populations have initial Hf-isotope compositions mostly between +11.9 to +5.0 (n = 23) with the exception of one ca. 95 Ma grain that yielded an  $\epsilon_{\text{Hf}}^{\text{fi}} = -9.3$ . Analyses of scattered older Mesozoic zircons reveal a range of  $\epsilon_{\text{Hf}}^{\text{fi}}$  values from +11.5 to -7.9 (t = ca. 358–189 Ma).

Biotite gneiss SK14-19 was collected near Estes Butte in the central southern portion of the main Swakane Gneiss exposure in the Wenatchee Block (Figure 3). The major Mesozoic peaks are centered at ca. 74 (n = 31) and 85 (n = 22); smaller clusters are found around ca. 95 Ma (n = 5), 114 (n = 3), 142 (n = 3), 153 (n = 4), and 207 Ma (n = 6). Proterozoic dates include a tight cluster at ca. 1385 Ma (n = 9), three dates between ca. 1434–1403 Ma, and sixteen scattered dates between ca. 1875–1605 Ma. The ca. 74 and 85 Ma populations have elevated U/Th ratios (above ~10), whereas all other grains have U/Th < 10. Zircon rims range between ca. 83–64 Ma. The ca. 77–64 Ma (n = 7) rims are dominantly irregular growths and are found on ca. 1793–79 Ma cores. In comparison, the ca. 83–80 Ma rims (n = 3) are on ca. 1694–1382 Ma cores. Cretaceous zircons have a wide range of initial Hf-isotope compositions: +5.3 and -17.0 (n = 4) for ca. 76–72 Ma grains and +12.2 to -22.1 (n = 9) for ca. 109–83 Ma zircons. Representative

Late Triassic zircons have  $\epsilon_{\text{Hf}}^{\text{Hf}}$  values of +10.8 and +9.8 (ca. 206 Ma and 210 Ma, respectively). Two zircons from the younger Proterozoic peak have  $\epsilon_{\text{Hf}}^{\text{Hf}}$  values of +5.6 and -0.3 (ca. 1382 and 1386 Ma, respectively), and three zircons from the older Proterozoic peak have  $\epsilon_{\text{Hf}}^{\text{Hf}}$  values between +4.7 and -4.6 (t = ca. 1793–1669 Ma).

Biotite gneiss SK16-01 was collected within the Eagle Creek horst, which crops out in the Chumstick Basin (Figure 3). The sample contains a small amount of muscovite, and small garnets (0.5–1 mm) are only observed within biotite grains. Zircons yield Mesozoic dates that include closely spaced peaks at ca. 79 (n = 6), 83 (n = 7), and 91 (n = 23) Ma and older peaks at ca. 120 (n = 10), 145 (n = 4), and 160 Ma (n = 12). Proterozoic populations include a tight cluster at ca. 1379 (n = 10) Ma, five dates between ca. 1466–1415 (n = 5), and scattered dates between ca. 1841–1615 Ma (n = 12). All zircons have thin rims, and three analyses of rim that were large enough to analyze yielded Late Cretaceous dates between ca. 70–68 Ma (n = 3) with U/Th > 40. One analysis of a mantle zone surrounded by a thin, unzoned rim has a ca. 82 Ma date and U/Th = 53. Zircons with dates less than ca. 100 Ma have  $\epsilon_{\text{Hf}}^{\text{Hf}}$  values between +8.5 to -12.1 (n = 6). Within the ca. 120 Ma population,  $\epsilon_{\text{Hf}}^{\text{Hf}}$  values range from +10.7 to -9.1 (n = 4). Jurassic (ca. 165–153 Ma) and Proterozoic (ca. 1727–1370) zircons have only positive  $\epsilon_{\text{Hf}}^{\text{Hf}}$  values between +11.0 to +6.0 (n = 5) and +6.7 to +2.2 (n = 4), respectively.

## Tables DR1-DR2

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