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THE MIDDLE CRUST OF THE WYOMING PROVINCE – GROUND-TRUTHING ABOVE 2000 METERS ELEVATION IN THE BEARTOOTH MOUNTAINS, MONTANA AND WYOMING

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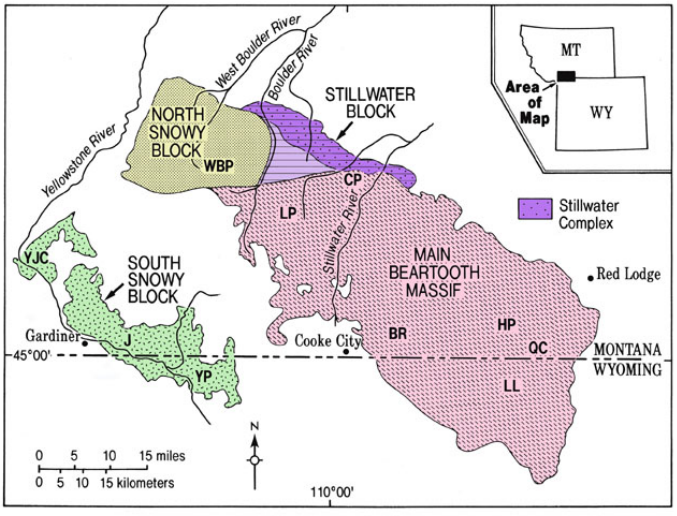
A significant challenge for EarthScope will be to develop geologic and geophysical studies that can distinguish crustal discontinuities at a range of scales and at resolutions high enough to discern structural and lithologic boundaries and to relate these discontinuities to structures in the mantle lithosphere. To gain an insight into the lithologic and structural complexity of the middle crust that is likely to be imaged over large areas in the Northern Rocky Mountains, we can examine Archean crust exhumed from middle crustal levels in the cores of mountain ranges uplifted during the Laramide Orogeny. The Archean rocks of the Beartooth Mountains of Montana and Wyoming provide an opportunity to examine, first-hand, the lateral and vertical distributions of formerly middle-crustal lithologies and the structures superimposed on them.

Archean rocks are exposed in the eastern and central Beartooth Mountains, Bighorn Mountains, and samples from deep-drill cores in eastern Wyoming and Montana are dominantly Late Archean granitoids, members of the tonalite-trondhjemite-granodiorite suite, with inclusions of older supracrustal rocks preserved as tectonic slices or pendants in the younger magmatic rocks. These are considered to be part of the Beartooth-Bighorn Magmatic Zone (BBMG). The Archean rocks in the western Beartooth Mountains and to the west are dominantly older high-grade gneisses with varying abundances of metasedimentary rocks. This area is generally termed the Montana Metasedimentary Province (MMP). The dominantly magmatic terrane in the eastern and central Beartooth Mountains and the high-grade gneiss terrane to the west are separated by a major discontinuity in the Archean basement marked by a mobile belt in the North Snowy Block, western Beartooth Mountains.



On a finer scale in the Beartooth Mountains we recognize four geographically and geologically distinct domains: the Beartooth massif, the Stillwater Block, the North Snowy Block and the South Snowy Block represent distinct lithologic, structural, and chronologic subdivisions. The main

Beartooth massif consists predominantly of voluminous Late Archean igneous granitoids (2.8-2.9 Ga) with inclusions of metasupracrustal rocks, which exhibit wide ranges in sizes (cm to km), composition, metamorphic grade, and isotopic age (to 3.3 Ga). The peak metamorphic conditions likely associated with the early stages of granitic magmatism are considered to be 5-7 kbar and 750-800ºC. The North Snowy Block is interpreted as a collage of several allochthonous units structurally juxtaposed against the main Beartooth Massif with latest Archean magmatism suggesting this juxtaposition occurred about 2.55 Ga. The Stillwater Block is dominated by the mafic layered Stillwater Complex (2.7 Ga) and its contact aureole that developed in older metasedimentary rocks. The South Snowy Block is dominated by lower grade metasedimentary rocks and a series of locally important 2.7 Ga old granitoid plutons.

EarthScope could address several additional questions that are related to the Beartooth and other Wyoming Province uplifts: What is the character of the faulting at depth that brought these middle crustal blocks to the surface and what is the relation of these faults to Archean structures? What is the nature of the crust below the 3000 m of mid-crustal level lithologies currently exposed in the Beartooth Mountains? Are major subprovince boundaries (e.g., BBMZ-MMP) largely vertical or horizontal structures? Do any of the geologically recognizable province or sub-province boundaries extend to the mantle?