Revised Geologic Site Characterization of the North Korean Test Site at Punggye-ri

On-line Appendix

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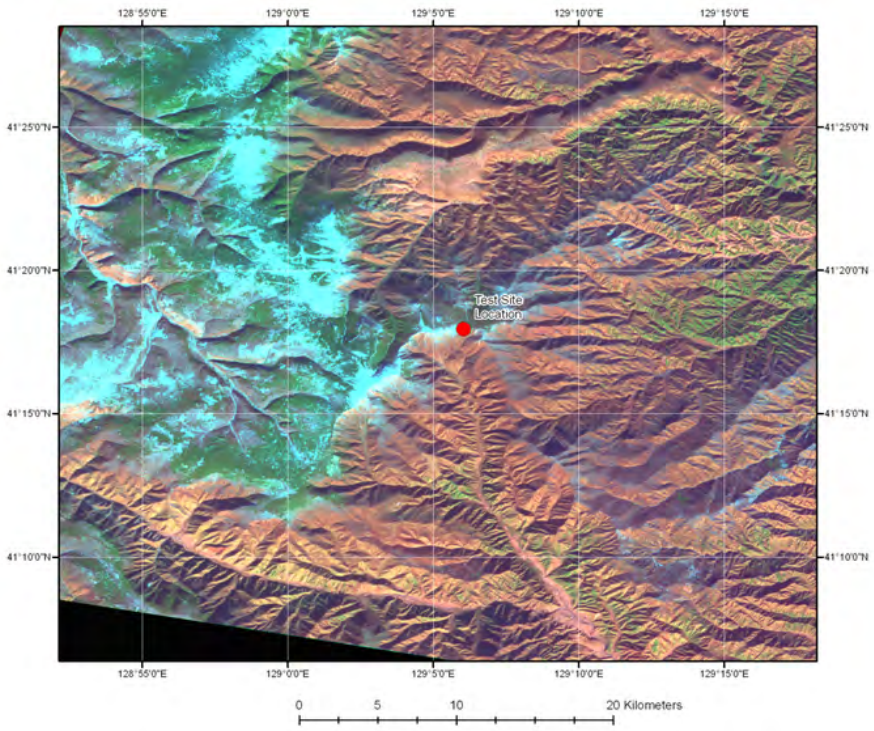

Figure A1 Upper: Coverage of the ASTER data used to derive the USGS geologic map of the Punggye-ri nuclear test site.

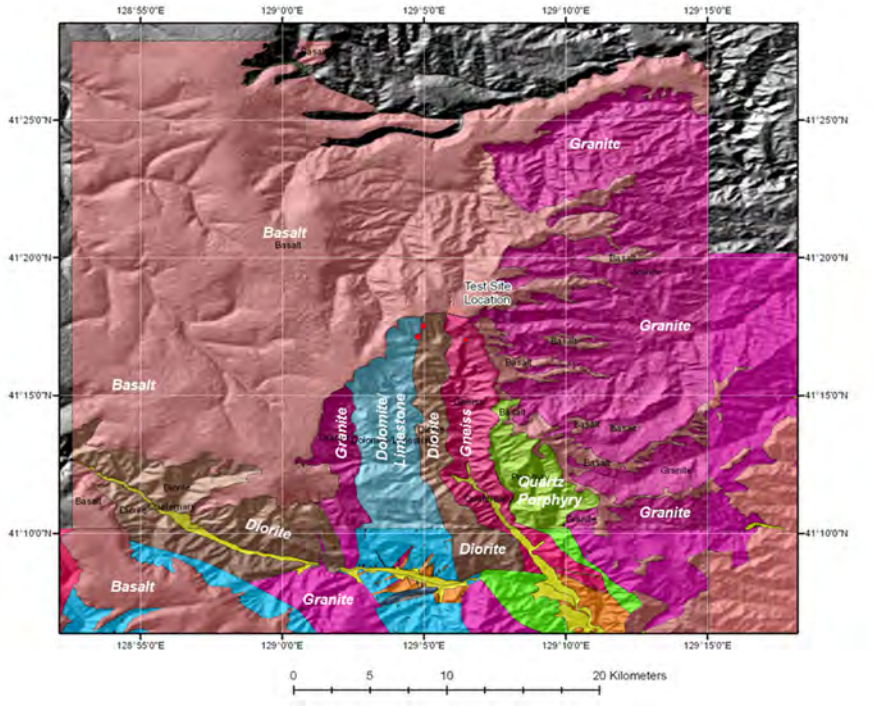

Figure A1 Lower: USGS reconnaissance based geologic interpretation (incorporating ASTER spectral data).

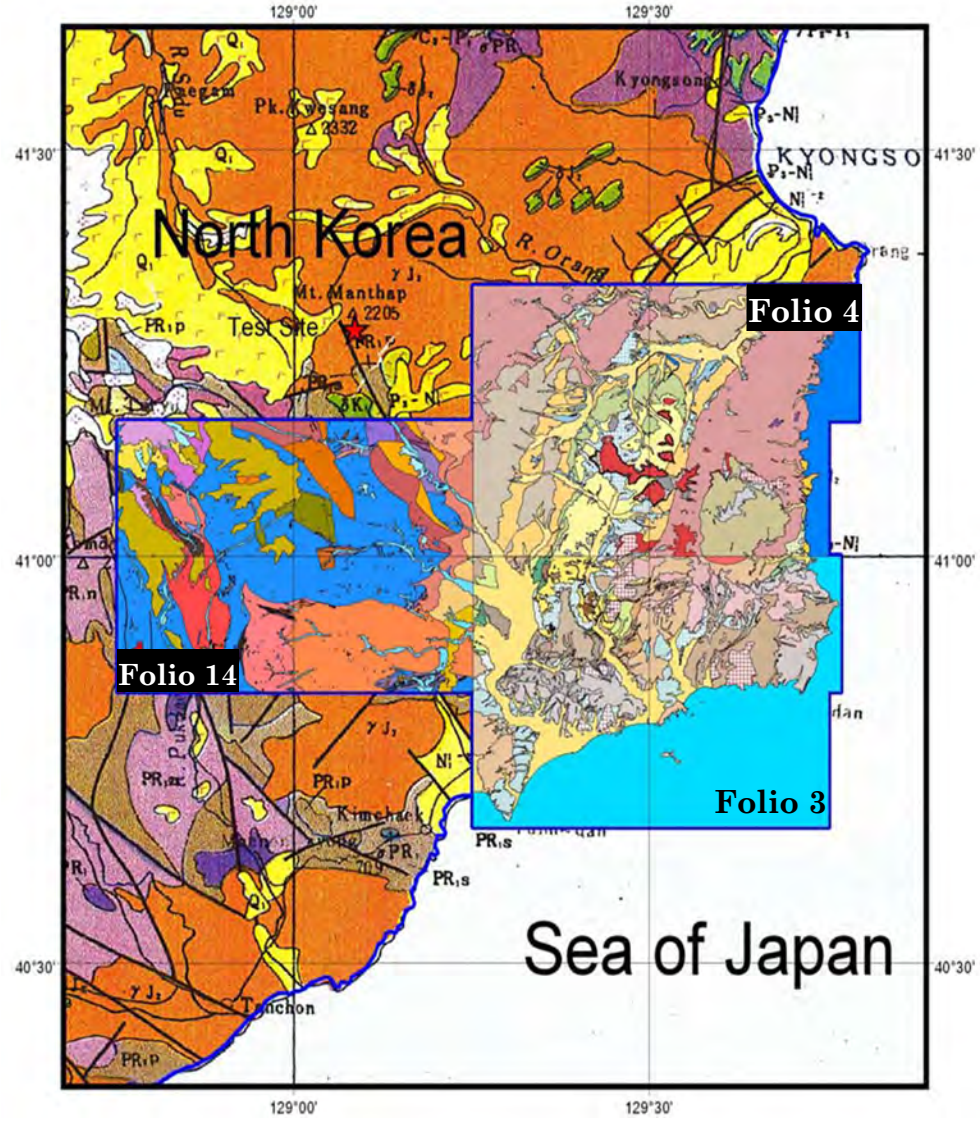

Figure A2: Details of the 1:50,000 scale geological folios 3, 4, and 14. From of the Geological Atlas of Chosen superimposed on the 1:1M scale geologic map of Korea (Central Geological Survey of Mineral Resources, 1994). The Punggye-ri nuclear test site is indicated by the red star near Mt. Manthap with a NW-SE trending fault just beneath it. (After Buttleman and Matzko, USGS, 2008, p. 9). The orange color on the North Korean sourced small scale (1:1M) map is labeled only as undifferentiated "Jurassic Granite".

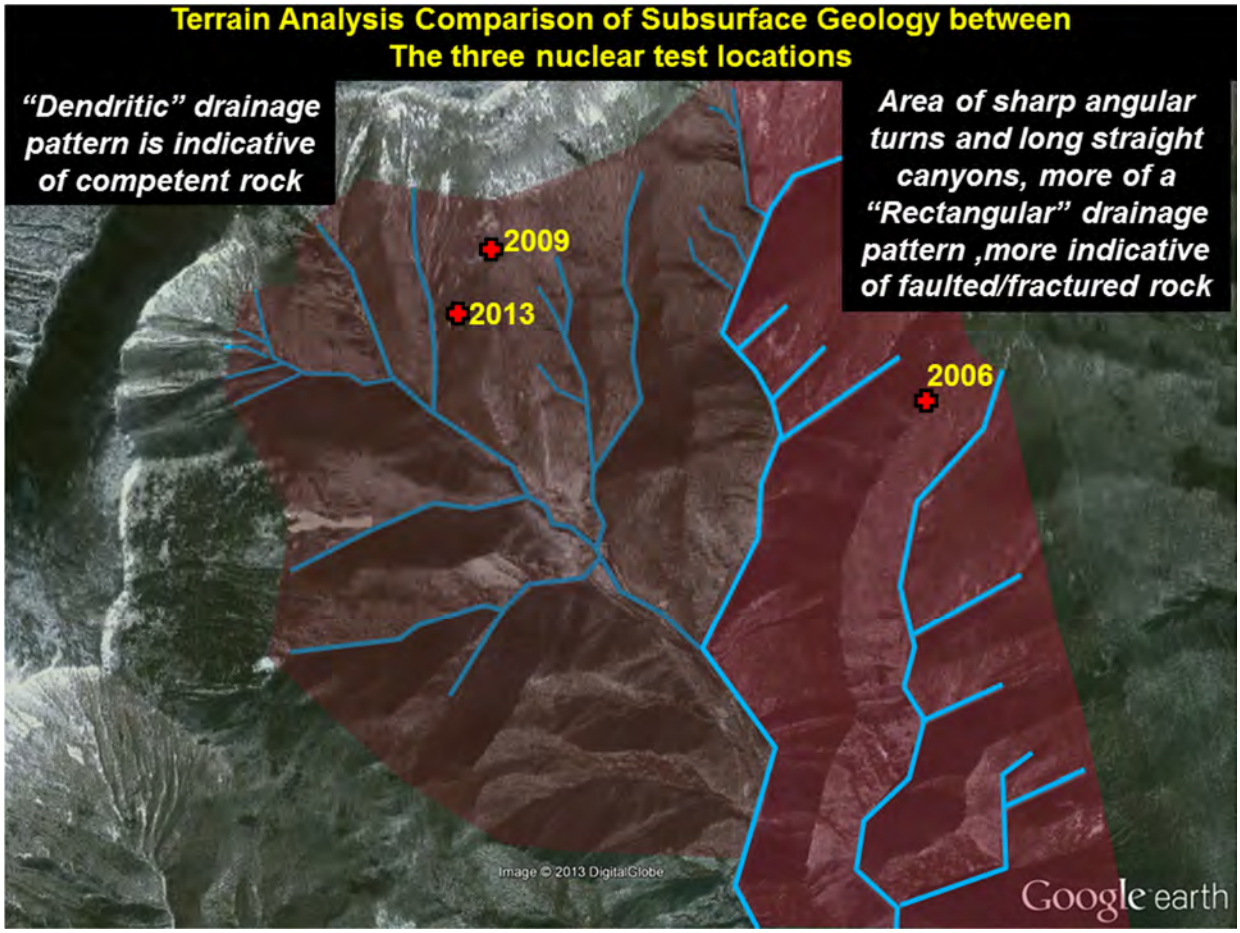

Figure A3: Subjective manual terrain analysis with respect to the openly identified event locations for the three North Korean underground nuclear tests conducted to date. The drainage pattern suggests a differential stream pattern consistent with two different rock types along a lithologic boundary as inferred and mapped by the USGS and separating the two types of host rock associated with underground nuclear testing.

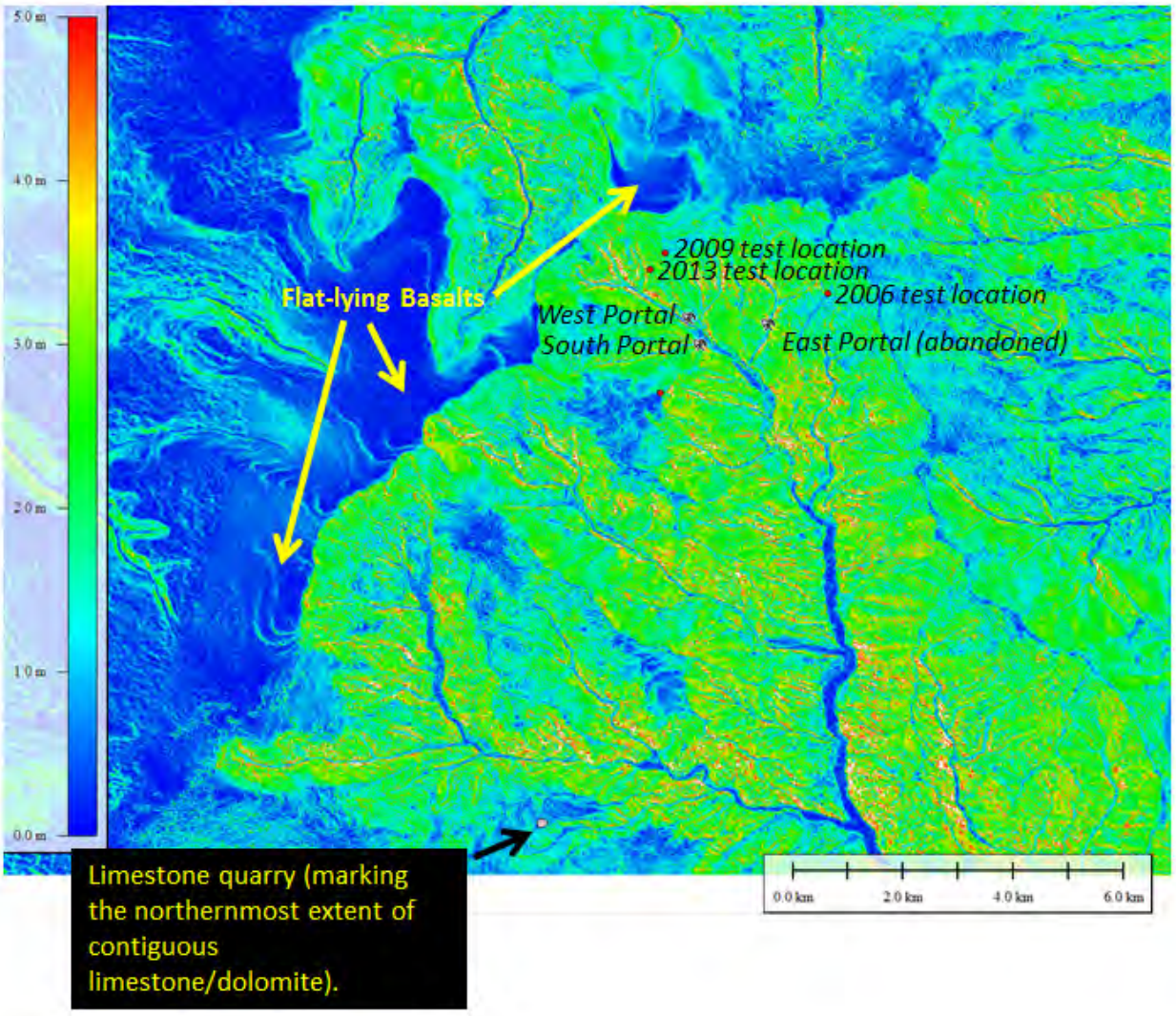

Figure A4: Rugosity (topographic roughness) of the Punggye-ri nuclear test site. Rugosity is calculated from the elevation data and algorithmically derived near neighbor grid comparisons

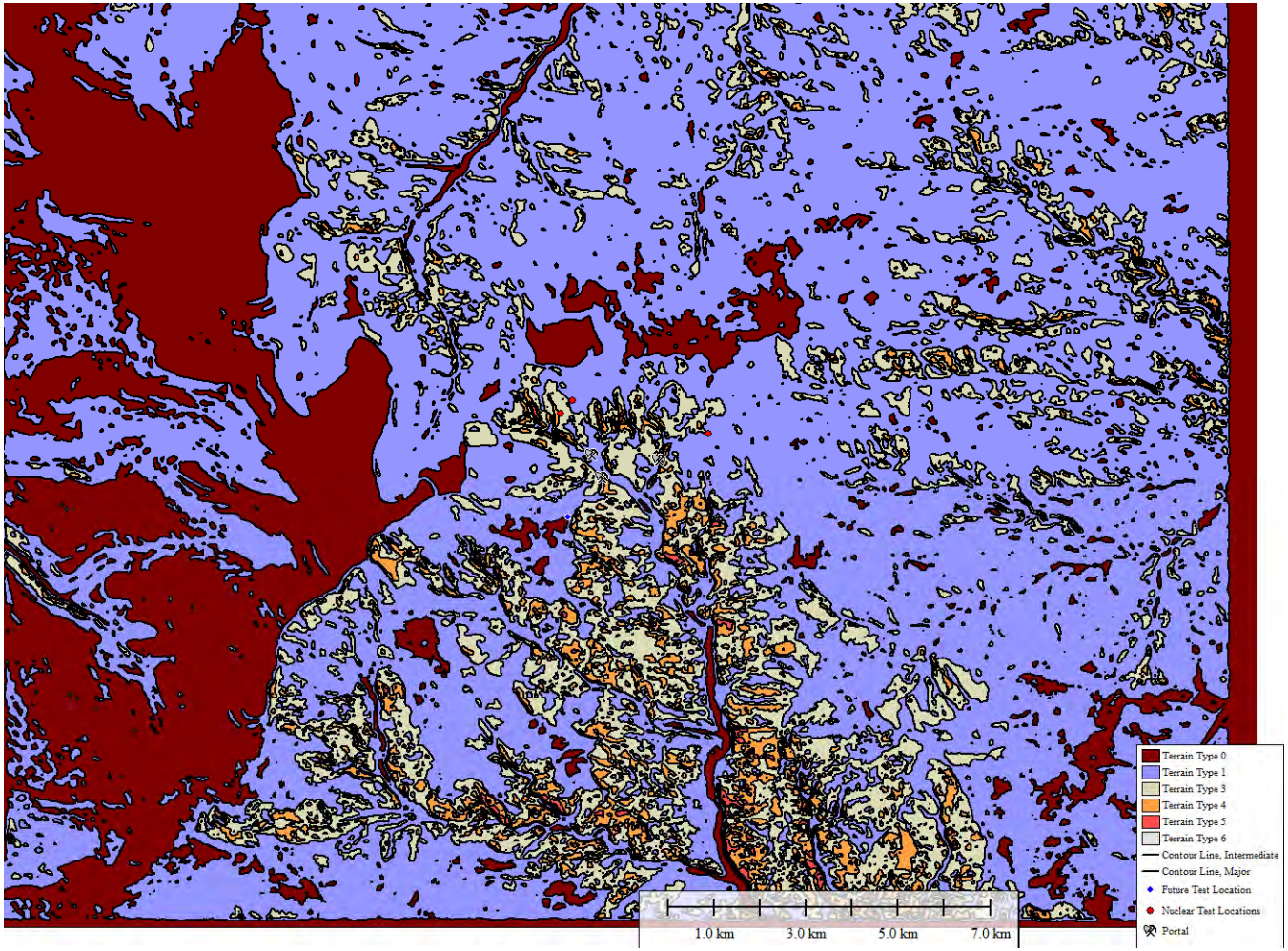

Figure A5: The complete terrain mapping for the Punggye-ri nuclear test site, based on seven terrain characterizations. Note that the portal locations (and corresponding subsurface tunnels) are located in complex terrain setting. Characterization methodology is discussed in Coblentz et al., 2014.

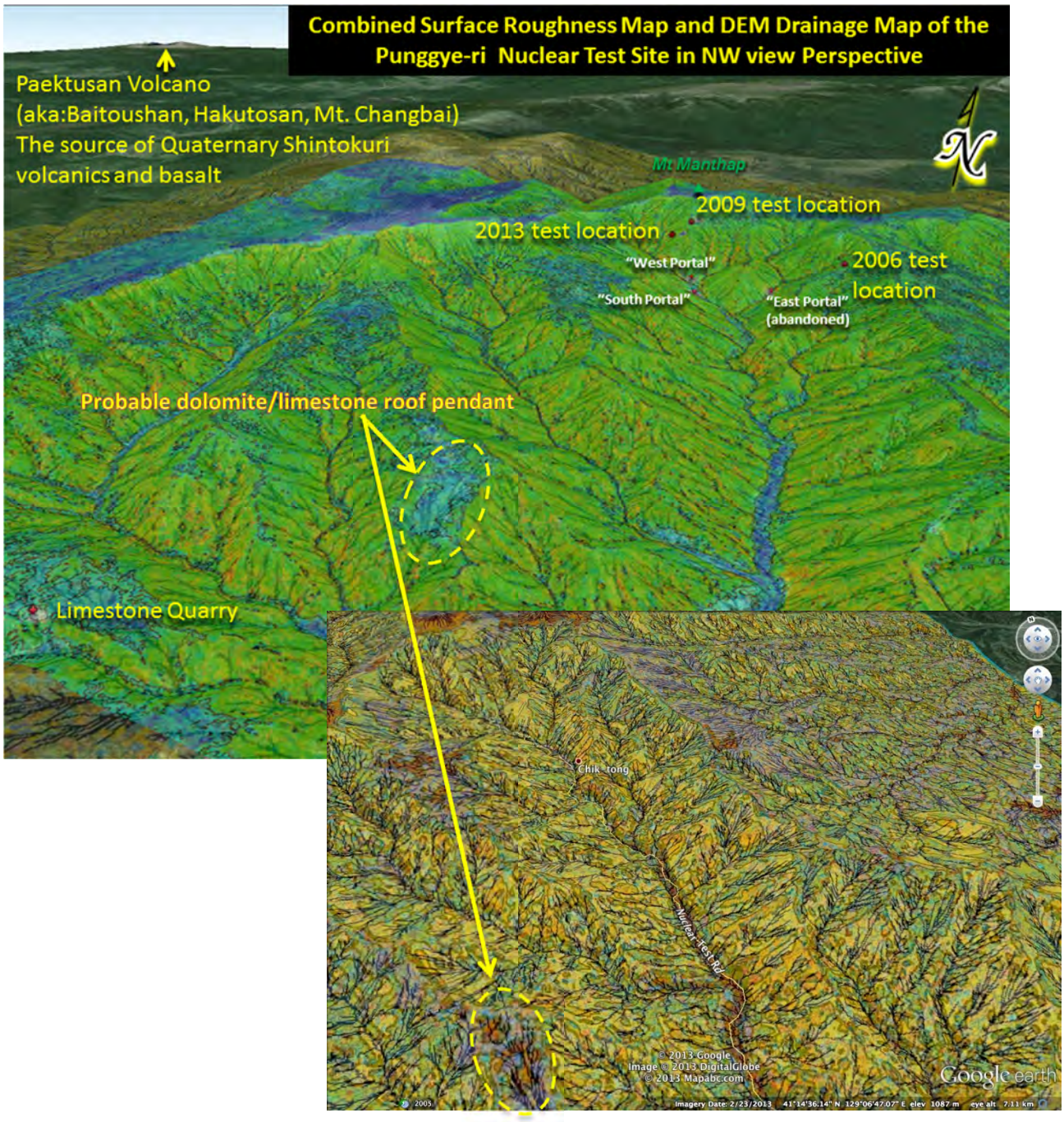

Figure A6: A combined rugosity (surface roughness) map and drainage map for the Punggye-ri nuclear test site. Upper: The derived stream drainage map is shown in perspective on Google Earth. The probable dolomite/limestone "roof pendant" stands out in the lower left center of this combined image. Lower: Terrain types overlain on drainage map, again showing the unique cohesive qualities suggestive of a dolomite/limestone "roof pendant" inside the yellow oval.

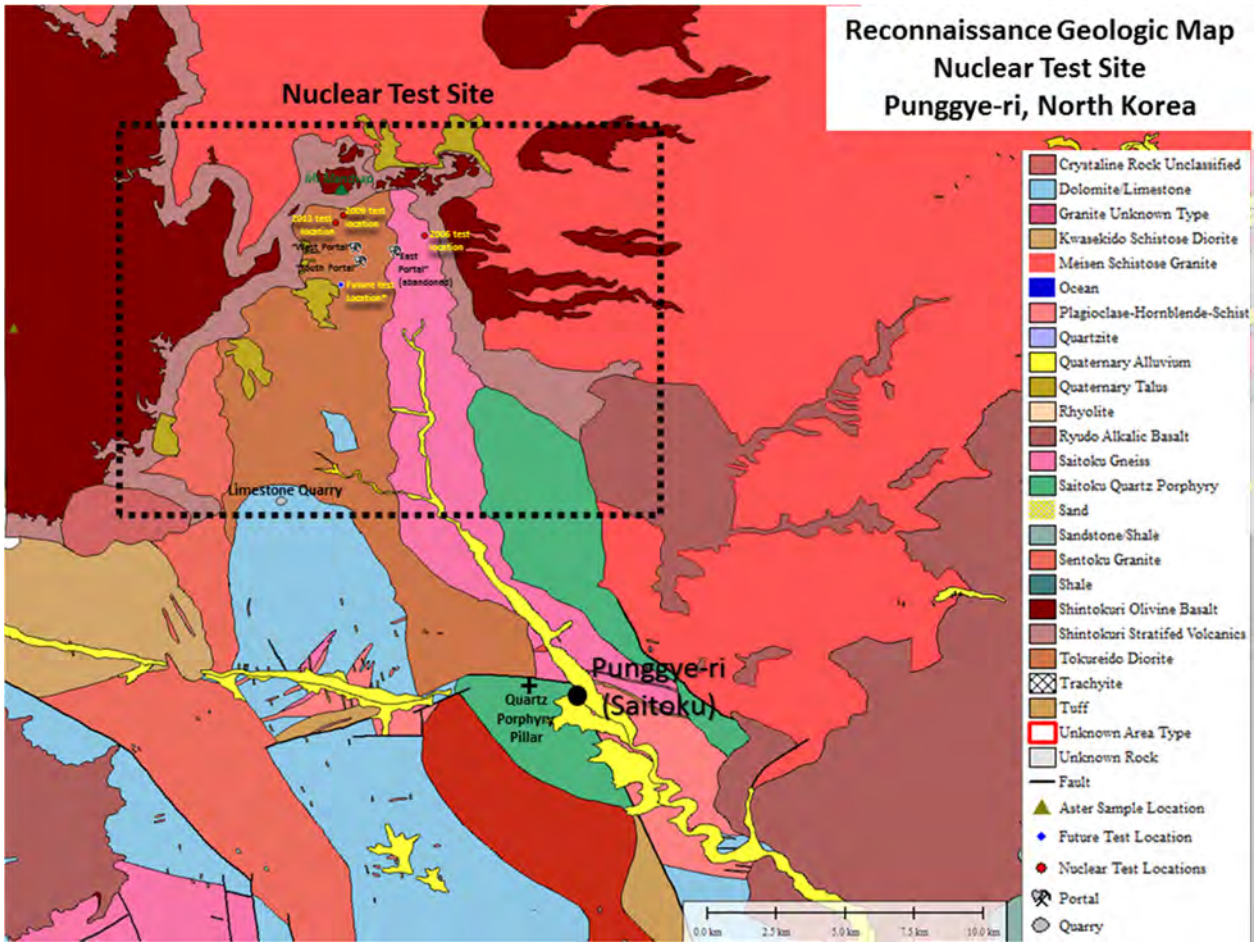

Figure A7: The derived regional geologic map of the Punggye-ri nuclear test site.

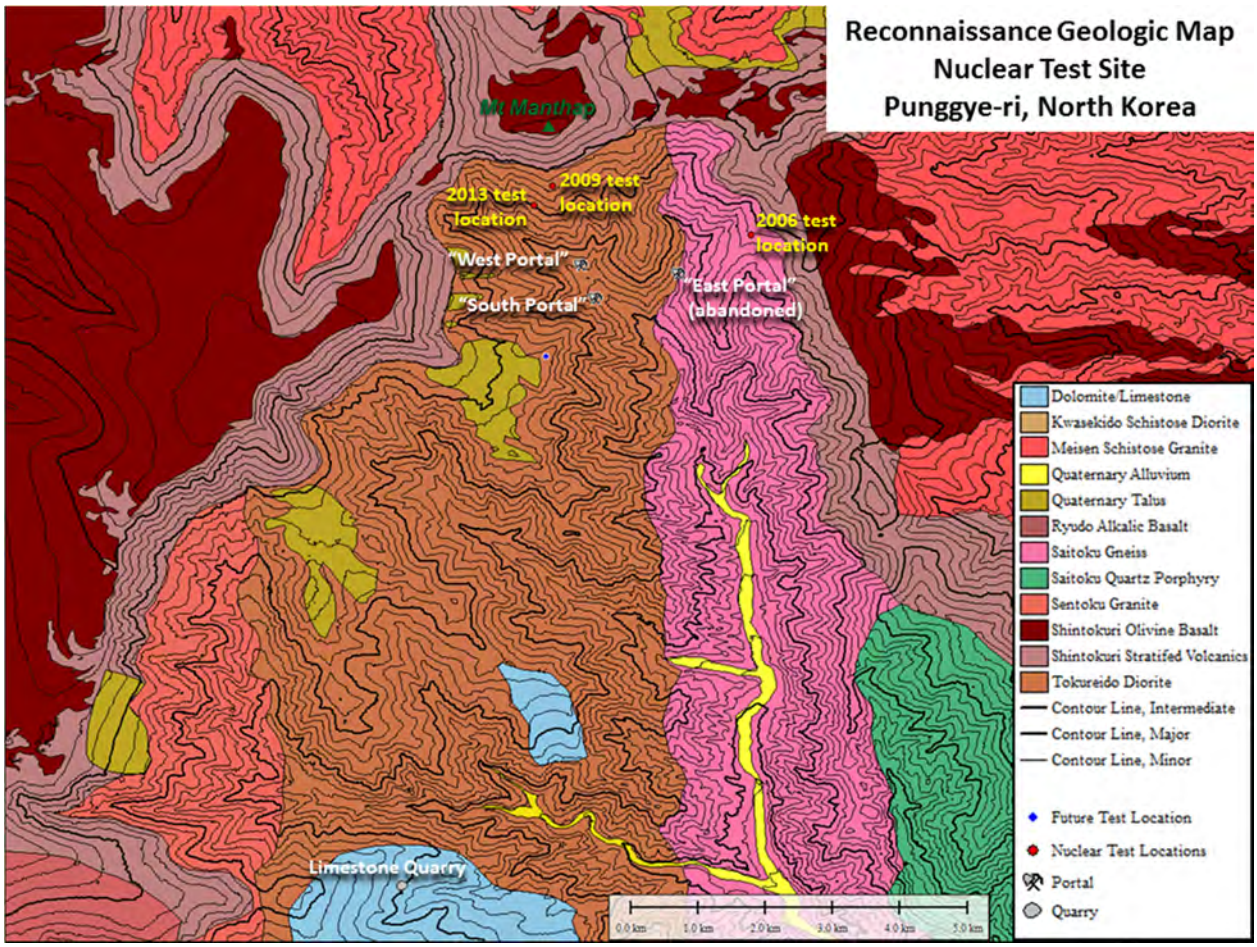

Figure A8: The derived local large-scale geologic map of the Punggye-ri nuclear test site.

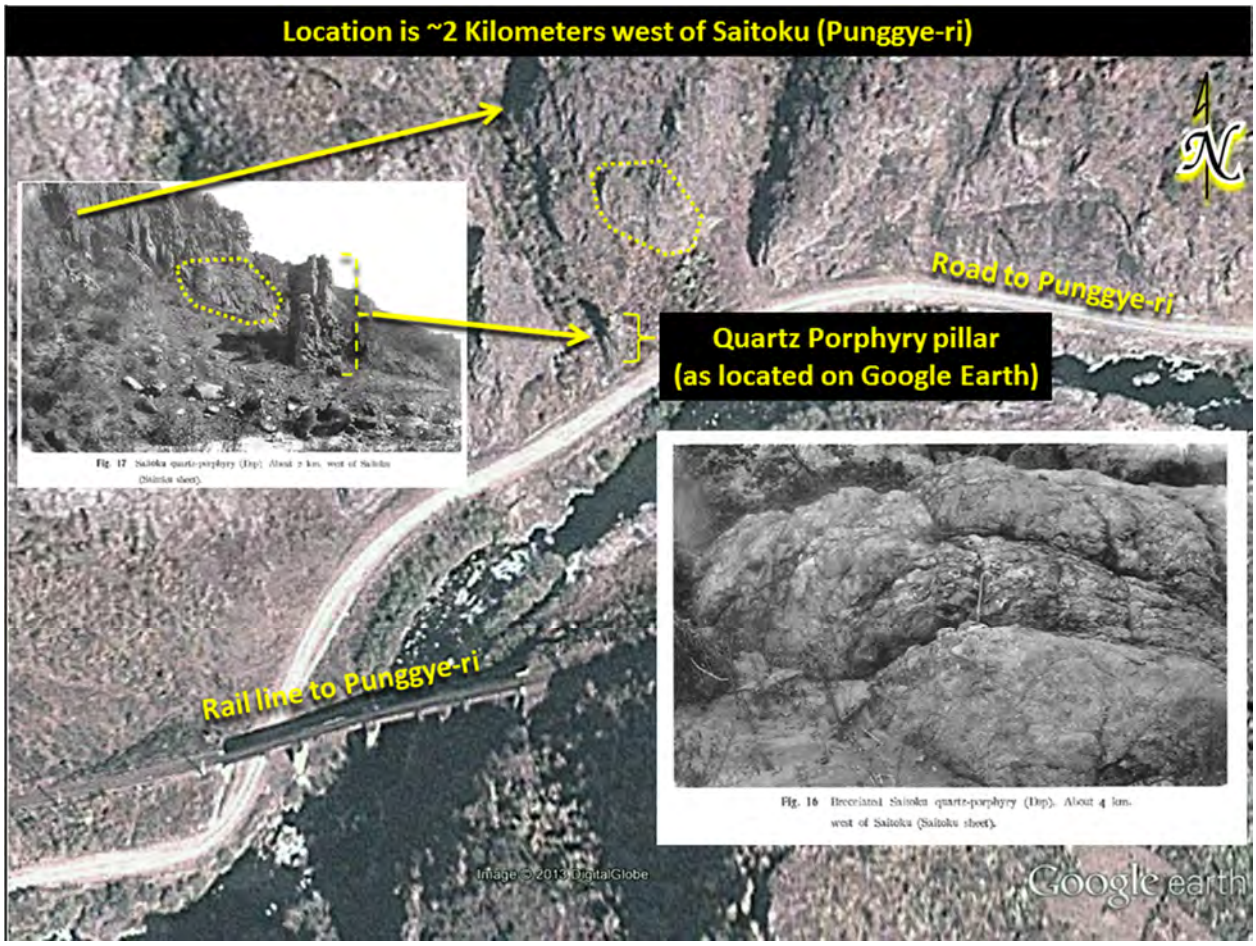

Figure A9: Ground photos taken circa 1932 of the highly fractured Saitoku quartz porphyry of the Cretaceous-Jurassic age. Given the location information regarding the rock pillar in the Japanese Folio #4 (2 kilometers west of Saitoku (now Punggye-ri)), it was possible to locate the rock pillar outcrop on Google Earth.

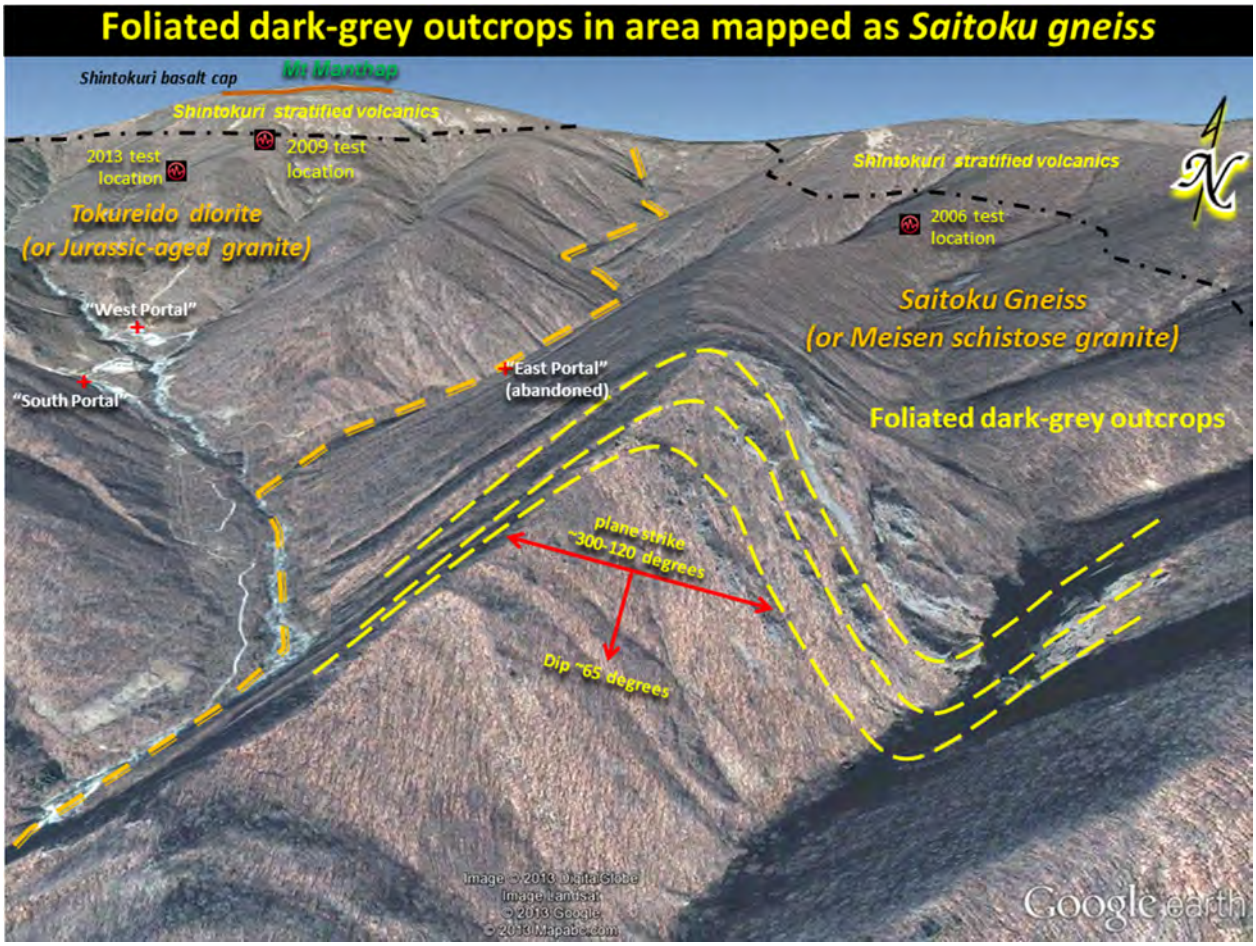

Figure A10: Google Earth overlay of the foliation patterns near the Punggye-ri nuclear test site. Highly foliated (and likely highly fractured) outcrops along the ridge associated with North Korea's first underground nuclear test in 2006 as observed on Google Earth in 3-D perspective looking north towards Mt. Manthap. Both our mapping and that of the USGS previously identify this as Saitoku gneiss. However, a strong case can also be made for this being the "unknown age" (probably Jurassic) "Meisen schistose granite" (see discussion in text).

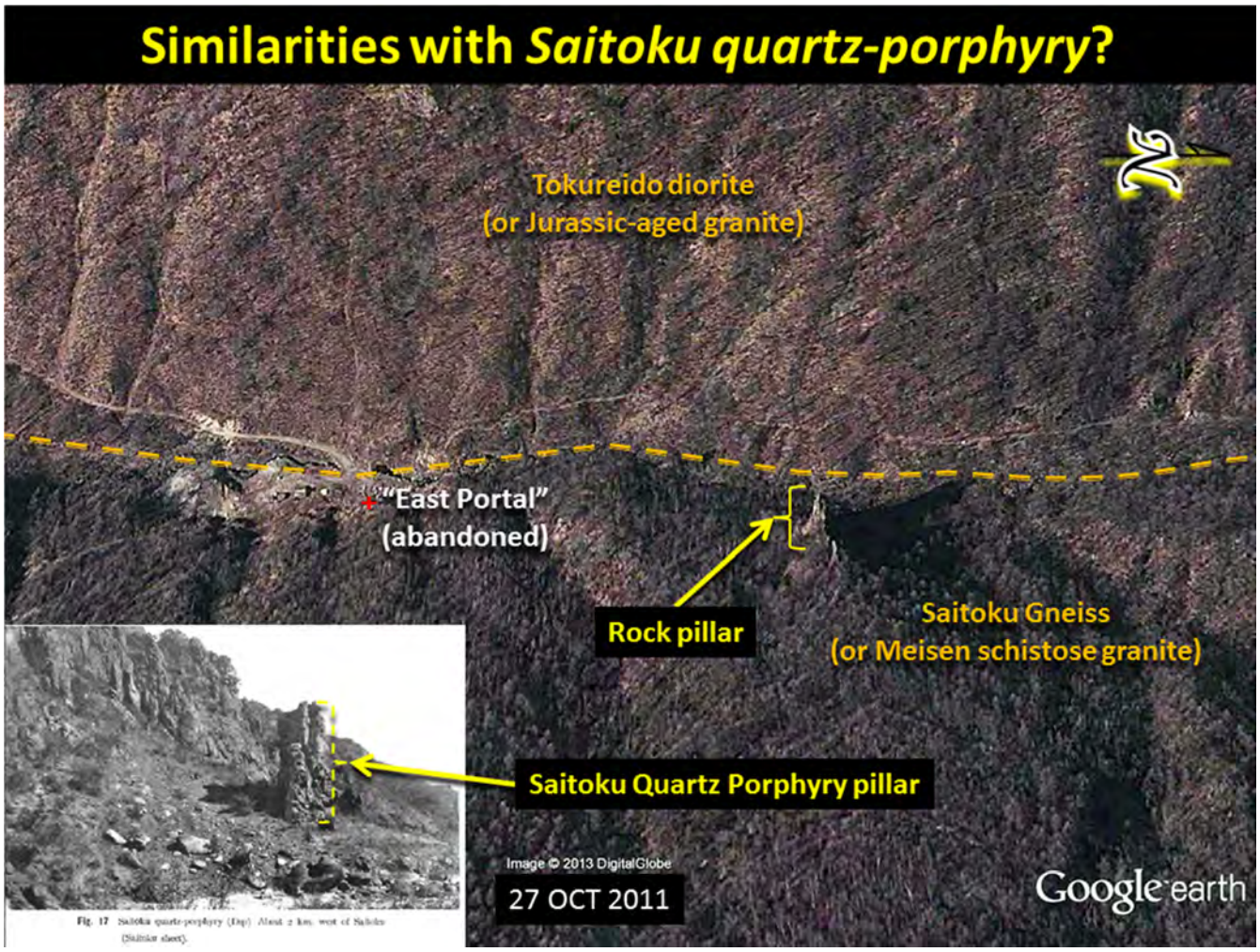

Figure A11: Google Earth image of a rock pillar in comparison with one identified in inset photograph obtained circa 1932 just west of the village of Punggye-ri. A prominent rock pillar, not unlike the quartz porphyry pillar (shown in the inset), is located near the "East Portal." This portal was associated with North Korea's first underground nuclear test (in 2006). The dashed line marks an inferred lithologic boundary.

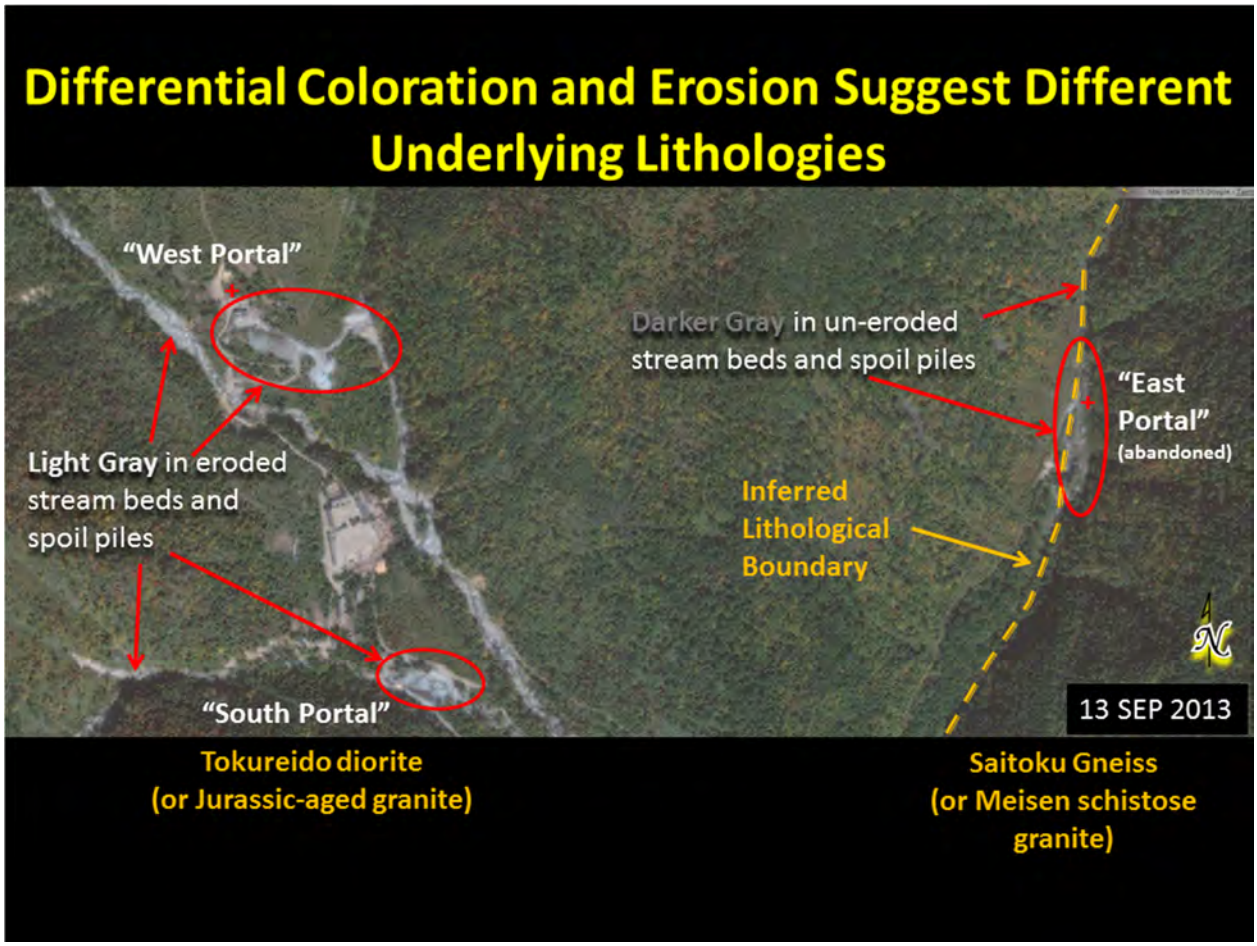

Figure A12: Differential coloration of excavated spoils at the tunneling locations of the Punggye-ri nuclear test site. Coloration variations and differential erosion across the inferred lithological boundary provide additional evidence of different underlying host-rocks.