4.6 Geology and Soils

This section describes the geological, mineral resources, seismic, and volcanic characteristics of INEEL, INTEC, and surrounding areas. A more detailed description of geology at INEEL can be reviewed in the SNF & INEL EIS, Volume 2, Part A, Section 4.6 (DOE 1995).

4.6.1 GENERAL GEOLOGY

INEEL occupies a relatively flat area on the northwestern edge of the Eastern Snake River Plain. Figure 4-***4*** shows important geological features of the INEEL area. The area consists of a broad plain that has been built up from the eruptions of multiple flows of basaltic lava, which is shown on Figure 4-***5***. The flows at the surface range in age from 1.2 million to 2,100 years. The Plain is bounded on the north and south by the north-to-northwest-trending mountains and valleys of the Basin and Range Provinces, comprised of folded and faulted rocks that are more than 70 million years old. The Plain is bounded on the northeast by the Yellowstone Plateau.

The seismic characteristics of the Plain and the adjacent Basin and Range Province are different. Earthquakes and active faulting are associated with Basin and Range tectonic activity. The Plain, however, has historically experienced infrequent small-magnitude earthquakes (King et al. 1987; Pelton et al. 1990; Jackson et al. 1993; WCFS 1996). The major episode of Basin and Range faulting began 20 to 30 million years ago and continues today, most recently with the October 28, 1983 Borah Peak earthquake, which was located approximately 50 miles to the northwest of INEEL. The earthquake had a moment magnitude of 6.9 with a ground acceleration of 0.022 to 0.078*g* at INEEL (Jackson 1985). No significant damage occurred at the INEEL (Guenzler and Gorman 1985).

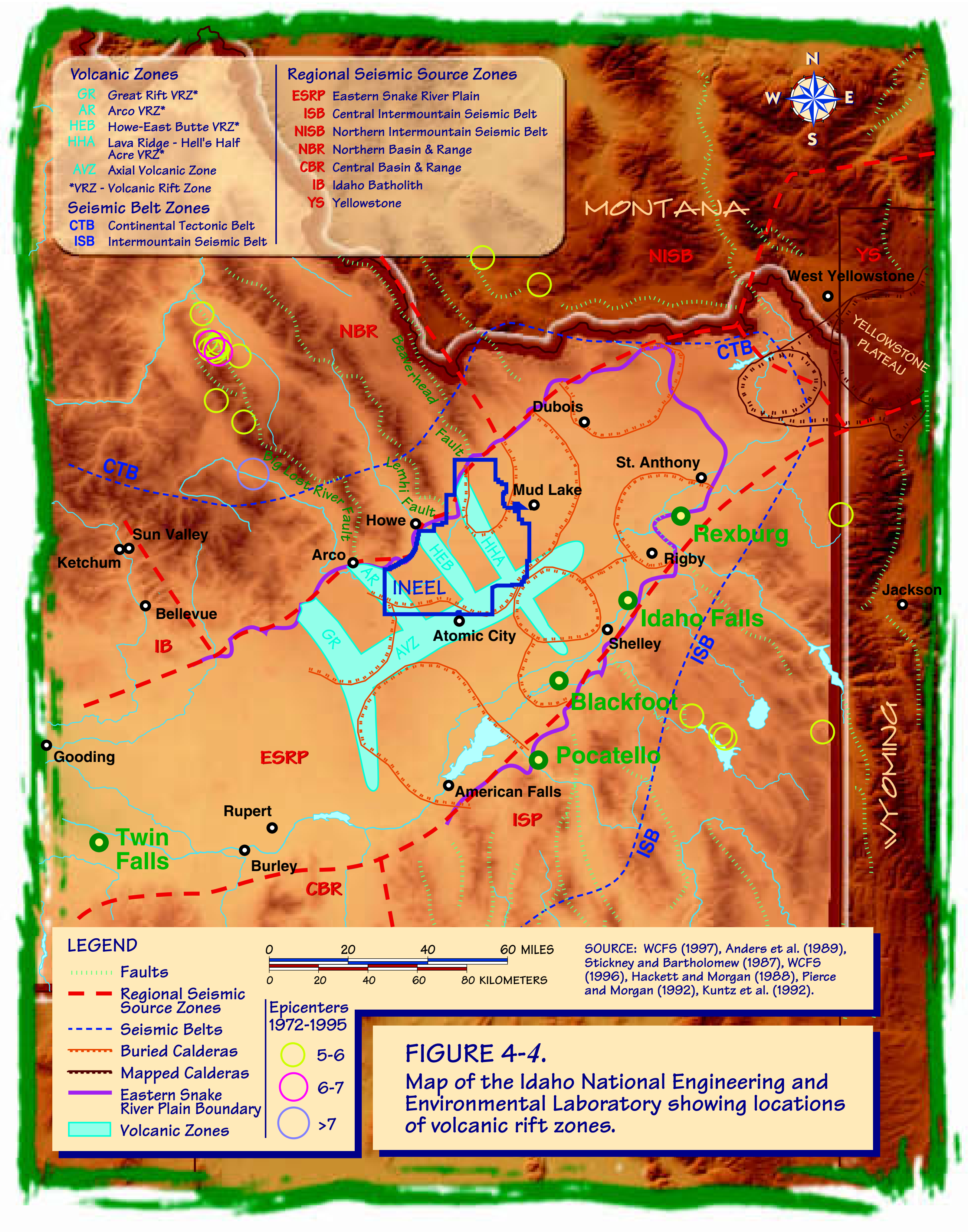
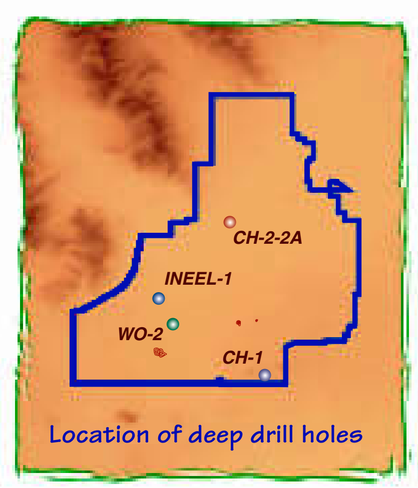
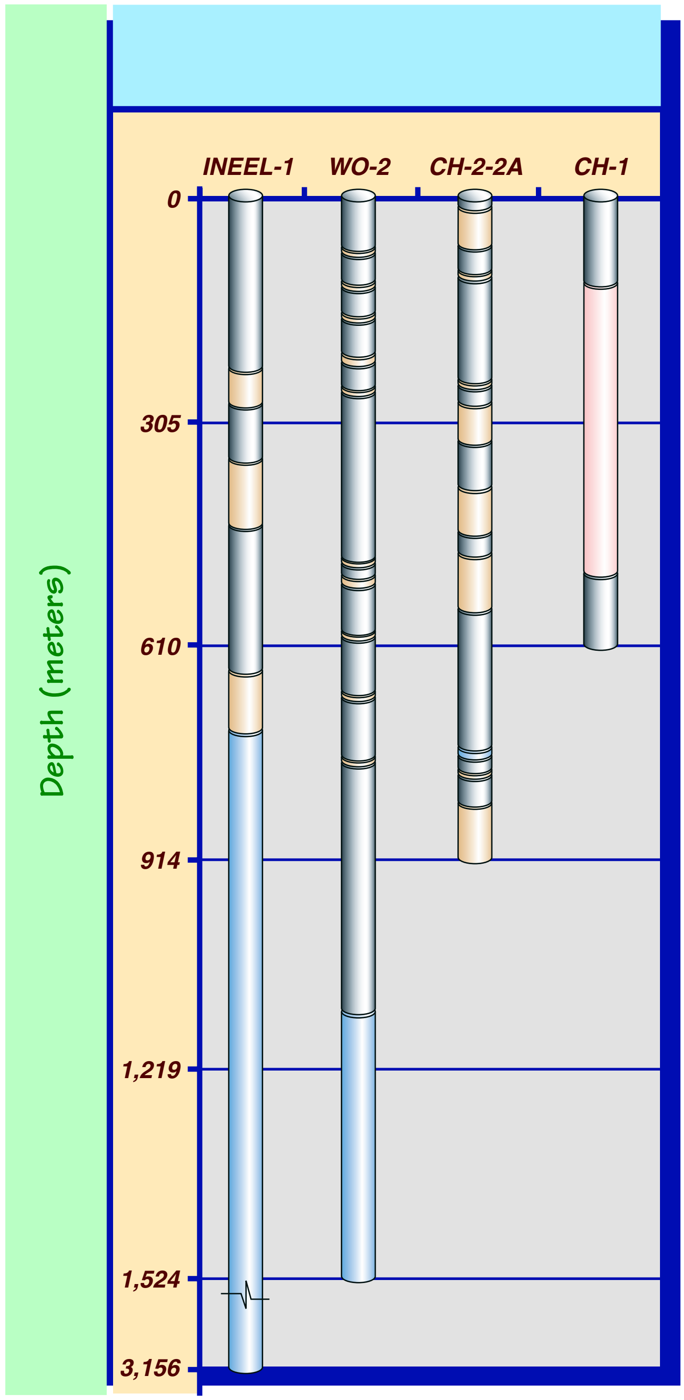


FIGURE 4-4.
Map of the Idaho National Engineering and Environmental Laboratory showing locations of volcanic rift zones.





LEGEND

- Quaternary basalt
- Major sedimentary interbed
- Quaternary rhyolite
- Tertiary rhyolite

SOURCE: Doherty (1979a,b), Doherty et al. (1979), and Hackett and Smith (1992).

FIGURE 4-5.
Lithologic logs of deep drill holes on INEEL.

Four northwest-trending volcanic rift zones are known to cut across the Plain at or near INEEL; they have been attributed to basaltic eruptions that occurred 4 million to 2,100 years ago (Hackett and Smith 1992, 1994; Kuntz et al. 1994).

INEEL surficial sediments are derived from rocks from nearby highlands. In the southern part of INEEL, the sediments are gravelly to rocky and generally shallow. The northern portion is composed mostly of unconsolidated clay, silt, and sand.

INTEC is situated adjacent to the Big Lost River in relatively flat terrain. Surface sediments are alluvial deposits of the Big Lost River composed of gravel-sand-silt mixtures 25 to 65 feet thick locally interbedded with silt and clay deposits ***up*** to 9.5 feet thick. The average elevation of INTEC is approximately 4,917 feet above mean sea level. Detailed stratigraphic information can be found in the *Comprehensive RI/FS for the Idaho Chemical Processing Plant OU3-13 at the INEEL - Part A RI/BRA Report* (Rodriguez et al. 1997).

As a result of past practices, radioactive and hazardous materials have been released to surface soils at the INTEC. Best management practices such as monitoring and spill control programs have been implemented to prevent future releases. Soil sampling including the remedial investigation sampling in 1995, was used to support the Operable Unit 3-13 Remedial Investigation/Baseline Risk Assessment and is documented in the *Comprehensive RI/FS for the Idaho Chemical Processing Plant OU3-13 at the INEEL - Part A RI/BRA Report* (Rodriguez et al. 1997). Contaminants found in the soil at INTEC include metals, organic compounds, and radionuclides. Results from Comprehensive Environmental Response, Compensation, and Liability Act risk assessment investigations at INTEC indicate that radionuclides are the most significant soil contaminants. Table 4-8 estimates the existing radionuclide activity and mass of non-radionuclide contaminants of concern in soils at INTEC.

4.6.2 NATURAL RESOURCES

INEEL mineral resources include sand, gravel, pumice, silt, clay, and aggregate. These resources are extracted at several quarries or pits at INEEL and used for road construction and maintenance, new facility construction and maintenance, waste burial activities, and ornamental landscaping. INTEC uses mineral materials extracted from the Test Reactor Area gravel pit 1 mile west of INTEC and the Lincoln Boulevard gravel pit approximately 7 miles north of INTEC. The geologic history of the ***Eastern Snake River*** Plain makes the potential for petroleum production at INEEL very low. The potential for geothermal energy exists at INEEL; however, a study conducted in 1979 identified no economic geothermal resources (Mitchell et al. 1980).

4.6.3 SEISMIC HAZARDS

The ***Eastern*** Snake River Plain has a relatively low rate of seismicity, whereas the surrounding Basin and Range has a fairly high rate of seismicity (WCFS 1996). The primary seismic hazards from earthquakes to INEEL facilities consist of the effects from ground shaking and surface deformation (surface faulting, tilting). Other potential seismic hazards such as avalanches, landslides, mudslides, and soil liquefaction are not likely to occur at INEEL because the local geologic conditions and terrain are not conducive to these types of hazards. Based on the seismic history and the geologic conditions, earthquakes greater than moment magnitude of 5.5 and associated strong ground shaking and surface fault rupture are not likely to occur within the Plain, but have been evaluated as part of a probabilistic seismic hazard analysis (WCC 1990; WCFS 1996). However, moderate to strong ground shaking from earthquakes in the Basin and Range ***could affect INEEL***.

Patterns of seismicity and locations of mapped faults are used to assess potential sources of

Table 4-8. Estimated activity of radionuclide and mass of non-radionuclide contaminants of concern in soils at INTEC.[a, b]

Radionuclide contaminant	Total activity (curies)	Non-radionuclide contaminant	Total mass (pounds)
Americium-241	110	Arsenic	1,000
Cesium-137	30,000	Chromium	300
Cobalt-60	170	Mercury	1,400
Iodine-129	0.13		
Neptunium-237	1.4		
Total Plutonium	1200		
Strontium-90	19,000		

a. Total volume of contaminated soil is approximately 240,000 cubic yards. Depth of contaminated soils ranges from surface to nearly 50 feet.

b. Source: Data from Rodriguez et al. (1997), Table 5-42. Includes soil contamination, known releases and service waste discharges (excluding injection well discharges).

future earthquakes and to estimate levels of ground motion at the INEEL, and specifically at INTEC. The principal sources of earthquakes that could produce ground motion at INEEL facilities are (WCC 1990; WCFS 1996):

- Faults – The three major range-front faults northwest of INEEL (see Figure 4-***4***):
  - Beaverhead Fault
  - Lost River Fault
  - Lemhi Fault
- Volcanic Zones – The Volcanic Zones on and around INEEL (see Figure 4-***4***):
  - Arco Volcanic Rift Zone
  - Axial Volcanic Zone
  - Great Rift Volcanic Rift Zone
  - Lava Ridge-Hell's Half Acre Volcanic Rift Zone
  - Howe-East Butte Volcanic Rift Zone
- Source Zones – Other regional source zones that could potentially produce earthquakes affecting INEEL:
  - Eastern Snake River Plain background seismicity
  - Northern Intermountain Seismic Belt 15 miles north northeast of INEEL
  - Northern Basin and Range adjacent to and northwest of INEEL
  - Central Basin and Range 50 miles southwest of INEEL
  - Idaho Batholith 50 miles west of INEEL
  - Yellowstone 70 miles northeast of INEEL

INEEL seismic design basis events are determined by the INEEL Natural Phenomena Committee and incorporated into the INEEL Architectural and Engineering Standards based on seismic studies (WCC 1990). New facilities and facility upgrades are designed in accordance with the requirements specified in the DOE-ID Architectural and Engineering Standards (DOE 1998), DOE Order 420.1, and *DOE Standard Natural Phenomena Hazards Design and Evaluation Criteria for Department of Energy Facilities* (DOE ***2002***). The mean peak ground acceleration, determined by the INEEL Natural Phenomena ***Hazards*** Committee, ***has been*** incorporated into the architectural and engineering standards. Section 5.2.14, Facility Accidents, presents the potential impacts of postulated seismic events.

4.6.4 VOLCANIC HAZARDS

Volcanic hazards include the effects of lava flows, fissures, uplift, subsidence, volcanic earthquakes, and ash flows or airborne ash deposits (Hackett and Smith 1994). Most of the basalt volcanic activity occurred from 4 million to 2,100 years ago in the INEEL area. The most recent and closest volcanic eruption occurred at the Craters of the Moon National Monument 26.8 miles southwest of INTEC's main stack (Kuntz et al. 1992). Based on probability analysis of the volcanic history in and near the south central INEEL area, the Volcanism Working Group (VWG 1990) estimated that the conditional probability that basaltic volcanism would affect a south-central INEEL location is less than once per 100,000 years or longer. The probability is associated primarily with the Axial Volcanic Zone and the Arco Volcanic Rift Zones. INTEC is located in a lesser lava flow hazard area of INEEL, more than 5 miles from the Axial Volcanic Zone and any volcanic vent younger than 400,000 years. The probability that basaltic volcanism would affect a south-central INEEL location is less than 2.5×10^{-5} (once per 40,000 years or longer). Because of the low probability of volcanic activity during the project duration, volcanism is not discussed further in this section.

4.7 Air Resources

This section describes the air resources of INEEL and the surrounding area. The discussion includes the climatology and meteorology of the region, a summary of applicable regulations, descriptions of radiological and nonradiological air contaminant emissions, and a characterization of existing levels of air pollutants. Emphasis is placed on changes in air resource conditions since the characterization performed to support the SNF & INEL EIS, Volume 2, Part A, Section 4.7 (DOE 1995), from which this EIS tiers. Additional background information is presented in Appendix C.2, Air Resources. ***Newly developed information on baseline radiological dose, foreseeable increases in dose, and consumption of Prevention of Significant Deterioration (PSD) increment is presented in Sections 4.7.3 and 4.7.4.***

4.7.1 CLIMATE AND METEOROLOGY

The Eastern Snake River Plain climate exhibits low relative humidity, wide daily temperature swings, and large variations in annual precipitation. Average seasonal temperatures measured onsite range from 18.8°F in winter to 64.8°F in summer, with an annual average temperature of about 42°F (DOE 1995). Temperature extremes range from a summertime maximum of 103°F to a wintertime minimum of -49°F. Annual precipitation is light, averaging 8.7 inches, with monthly extremes of 0 to 5 inches. The maximum 24-hour precipitation is 1.8 inches. The greatest short-term precipitation rates are primarily attributable to thunderstorms, which occur approximately 2 or 3 days per month during the summer. Average annual snowfall at INEEL is 27.6 inches, with extremes of 59.7 inches and 6.8 inches.

Most onsite locations experience the predominant southwest/northeast wind flow of the Eastern Snake River Plain, although terrain features near some locations cause variations from this flow regime. The wind rose diagrams in Figure 4-***6*** show annual wind flow. These diagrams show the frequency of wind direction (i.e., the direction from which the wind blows) and speed at three of the meteorological monitoring sites on INEEL for the period 1988 to 1992. Multi-year wind roses exhibit little variability and are representative of typical patterns. INEEL wind rose diagrams reflect the predominance of southwesterly winds that result during