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Geophysics of Old on the Hanford Site

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2023 Global Summit
on Environmental Remediation
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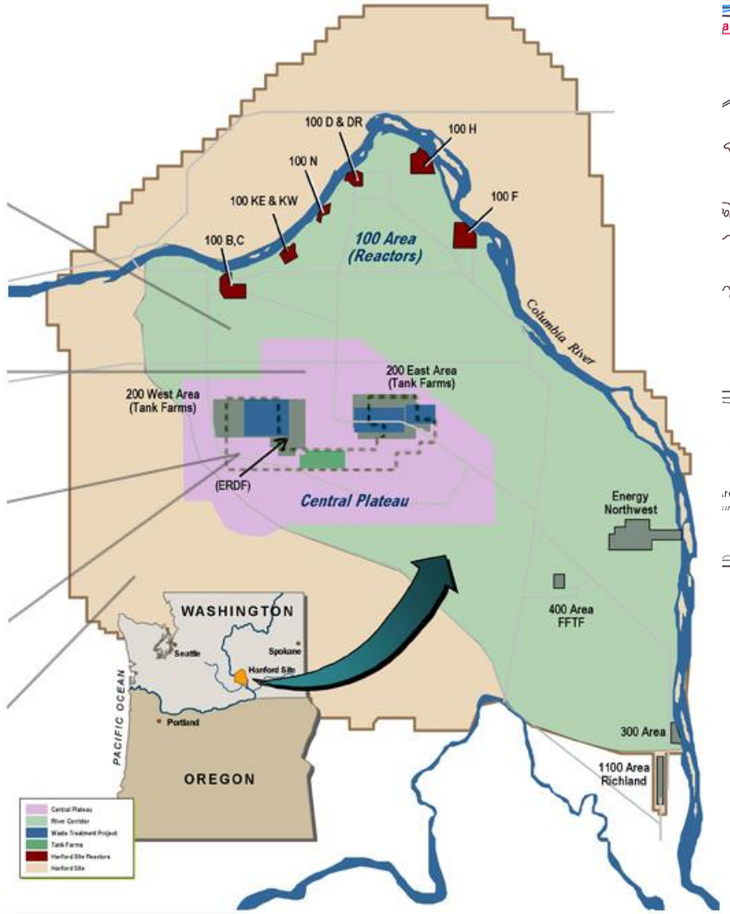
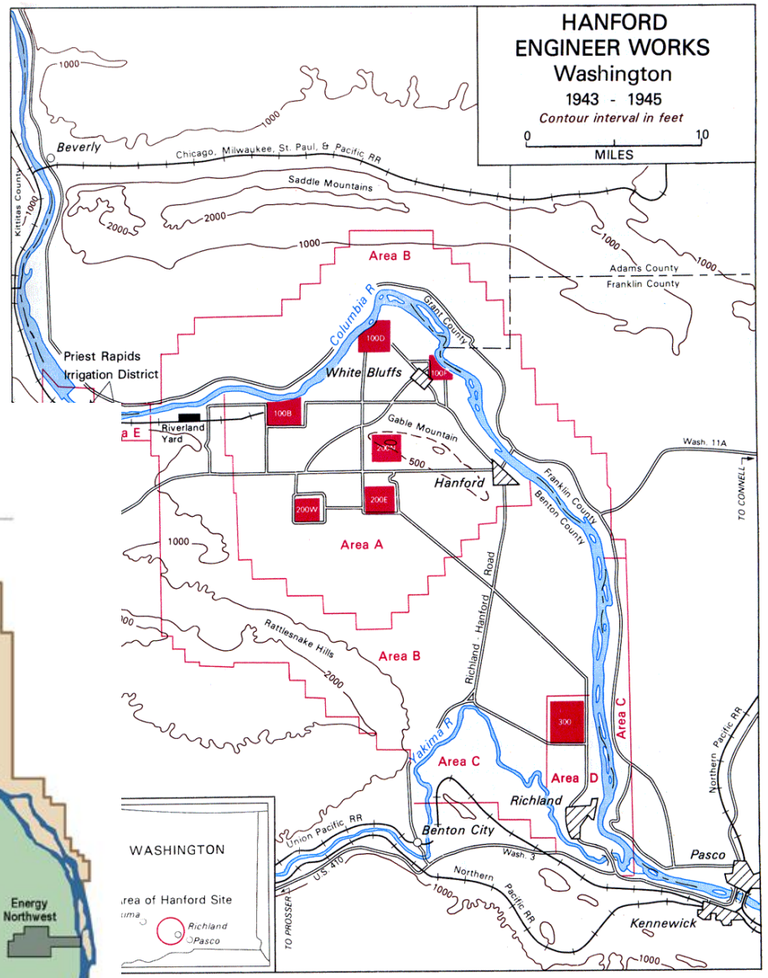
Outline

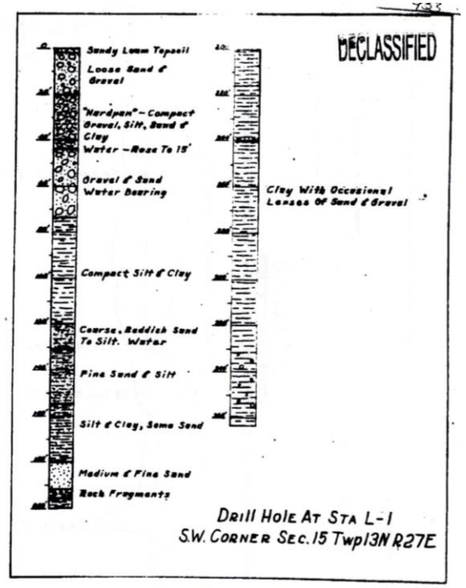
- Historical applications of geophysics on Hanford were extensive but had technical limitations
    1. 1940's Seismic for geotechnical information for sighting the chemical separations plants, referred to as the "Canyons"
    2. Basalt Waste Isolation Project (BWIP) Geologic repository





Seismic Methods at Hanford (1943)

- Used to determine geotechnical information
  - To site the “Canyons”
  - To determine depth to bedrock
  - Seismic velocities were correlated with the type and depth of soil material



THE GABLE PROJECT

DECLASSIFIED

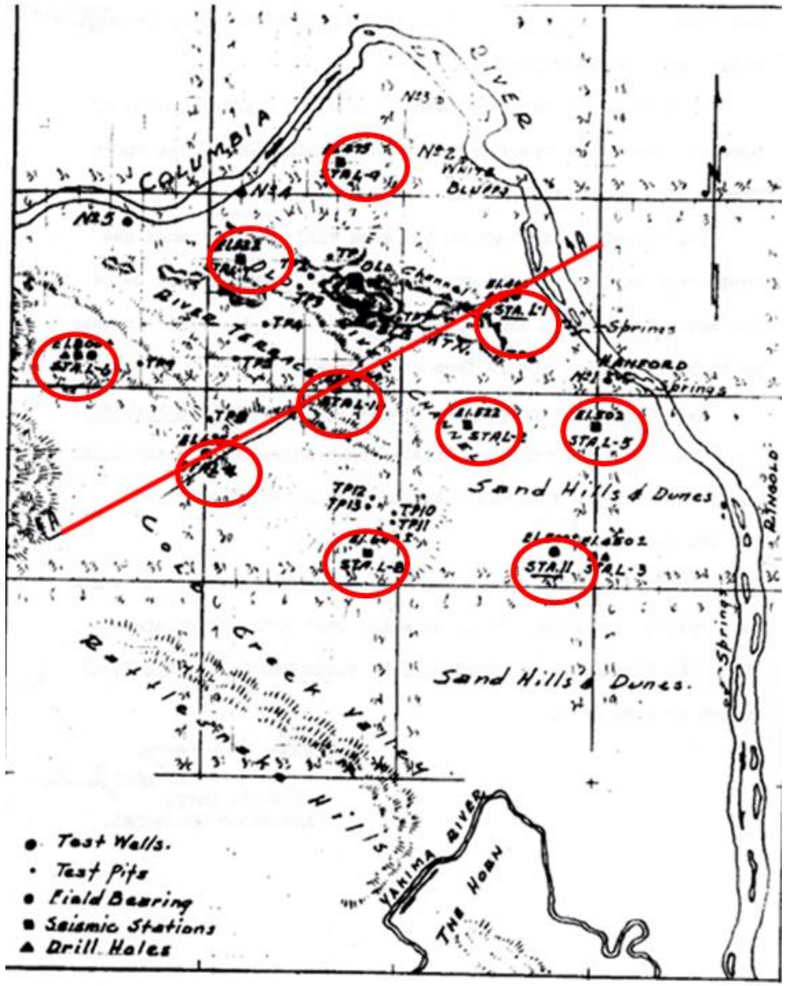
FIGURE 3

DECLASSIFIED

DDTS-GENERATED-435

Table 1

Station	Depth	Velocity ft/sec.	Material
L-1	± 7.4'	1300	Top soil
	± 36.6'	2150	Gravel & sand
	± 110' to 154'	6350	Cemented silt, sand & gravel.
L-2	± 6.1'	800	Top soil
	± 66.0'	3500	Gravel & sand
	± 140 to 212'	7270	Cem. silt, sand & gravel
L-3	± 12.1'	1100	Top soil
	± 48'	2300	Gravel & sand
	± 80 to 140'	8100	Cem. silt, sand & gravel
L-4	± 12.4'	1500	Top soil
	± 147'	2800	Gravel & sand
	± 170 to 300'	4400	Cem. silt, sand & gravel (poor)
L-5	± 8.7'	1100	Top soil
	± 126'	4100	Gravel & sand
		6900	Cem. silt, sand & gravel
L-6	± 18.0'	1600	Top soil
	± 166'	4450	Gravel & sand
	± 184'	7000	Cem. silt, sand & gravel
L-7	± 8'	1050	Top soil
	± 168'	3800'	Gravel & sand
	± 176 to 346'	10,700'	Basalt
L-8	± 25'	1400	Top soil
	± 188'	2800	Sand & Gravel
	± 213'	7560	Cem. silt sand & gravel
L-9	± 47.8	2000	Sand & gravel
	± 90 to 138'	8230	Cem. silt sand & gravel
L-10	± 10'	800	Top soil
	± 211'	2400	Sand & gravel
	± 221	13,000	Basalt



THE GABLE PROJECT

DECLASSIFIED

scale of Miles

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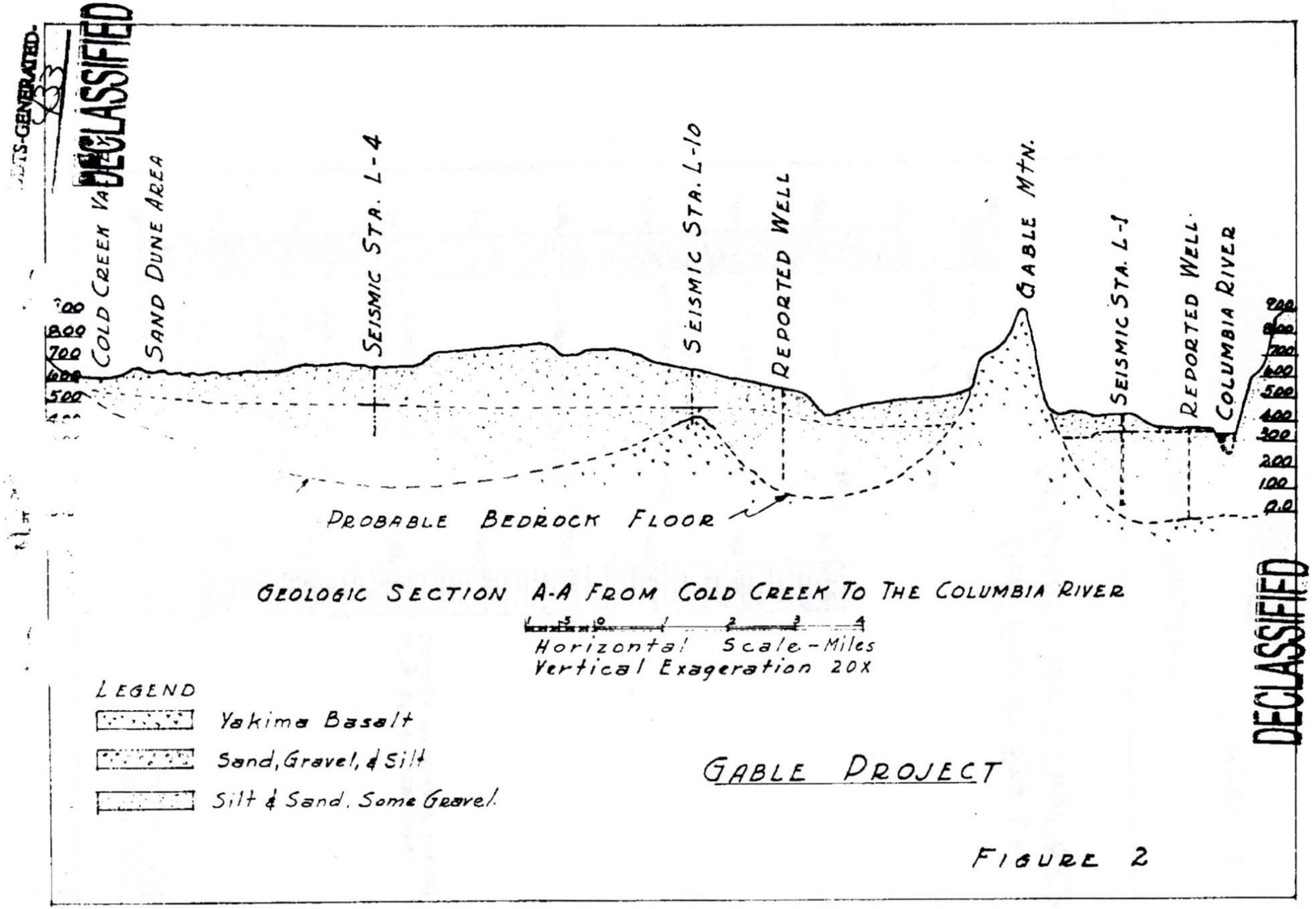
DDTS-433, Preliminary Geological Report Gable Site, January 28, 1943.



- One of the first conceptual site models of bedrock depth extrapolated from seismic surveys and boreholes
- Uncertainty regarding bedrock floor

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BWIP Geologic repository siting (late 1970-80s)

- Feasibility study to determine where to locate a repository for reactor irradiated fuel and other nuclear byproducts
  - Understanding the geoengineering properties of host rock
  - Evaluate the ability of host rock to provide a structural barrier to the migration of radionuclides
  - This was one site under consideration

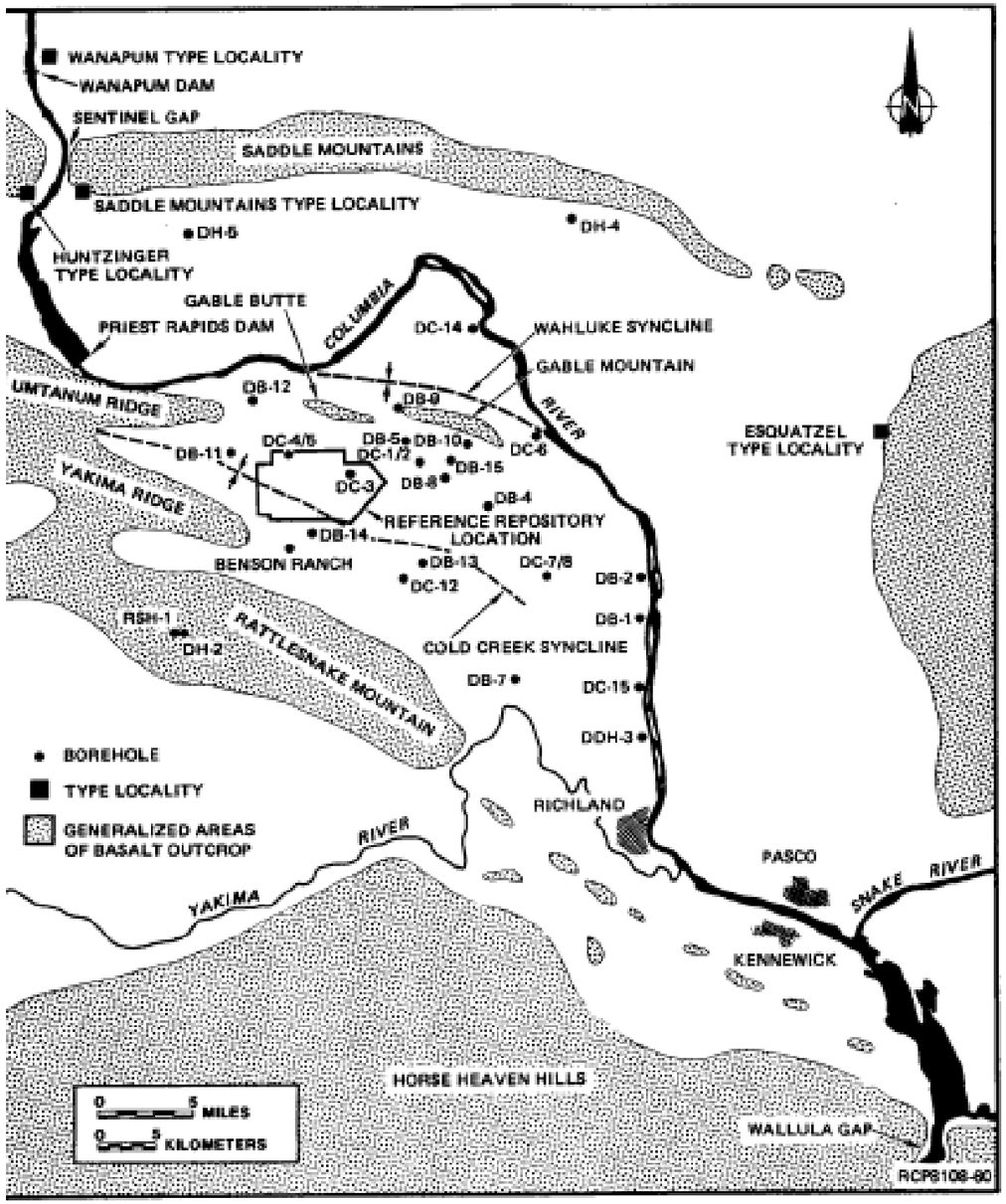

FIGURE 3-2. Location of Referenced Features, Pasco Basin and Nearby Area.

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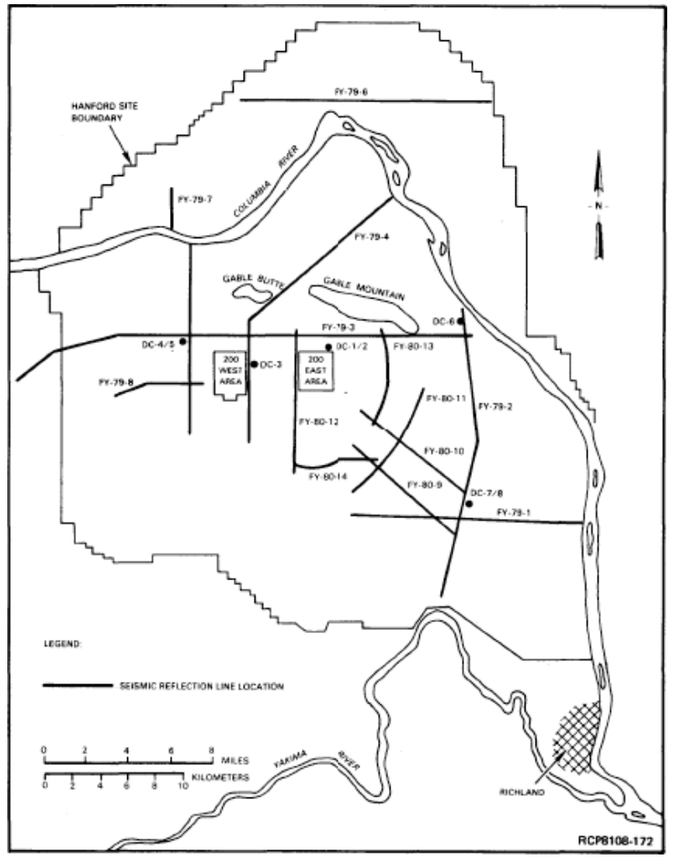
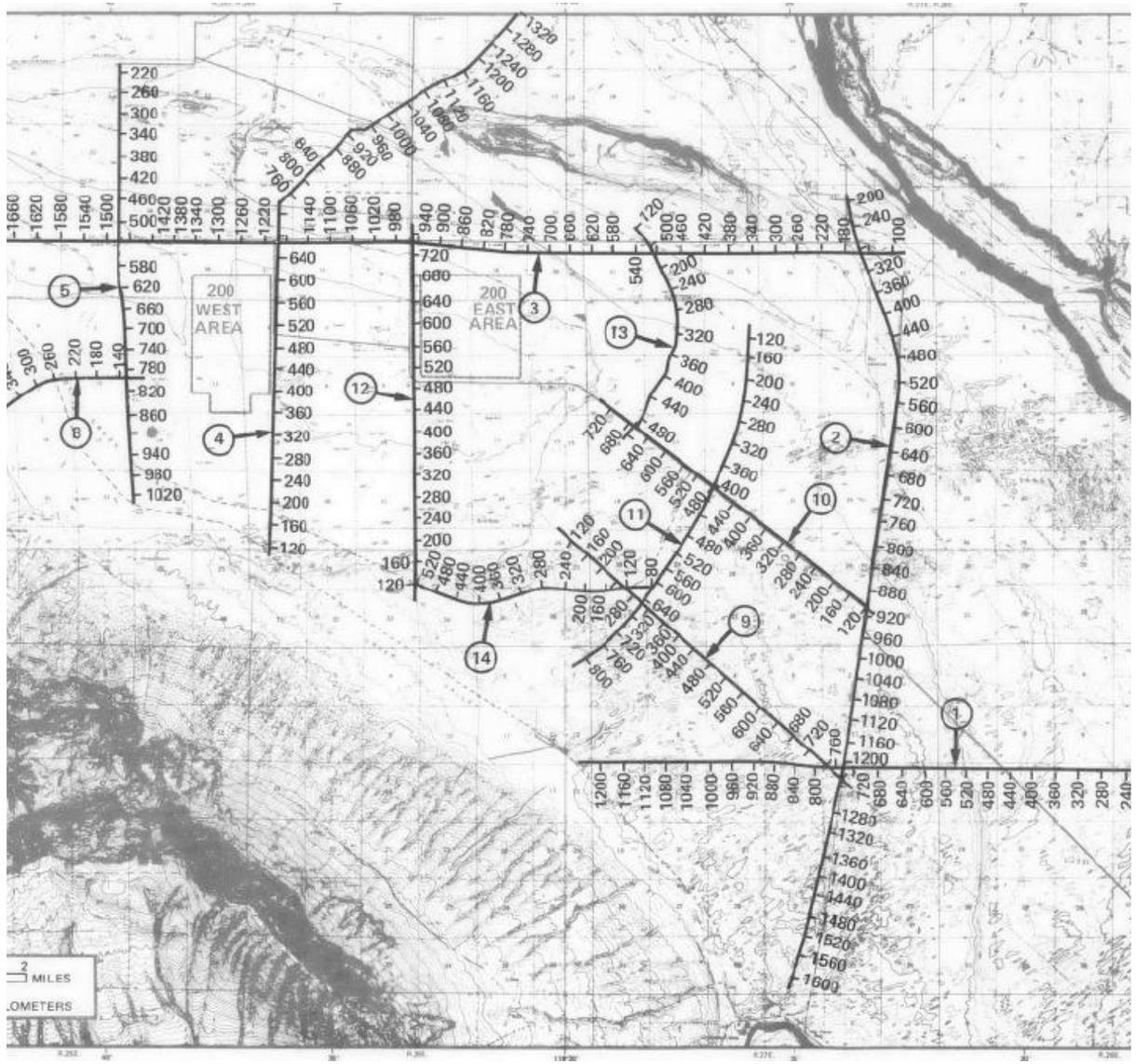
Seismic Reflection and Multilevel Aeromagnetic Surveys

Data field campaign in the Cold Creek Syncline Area





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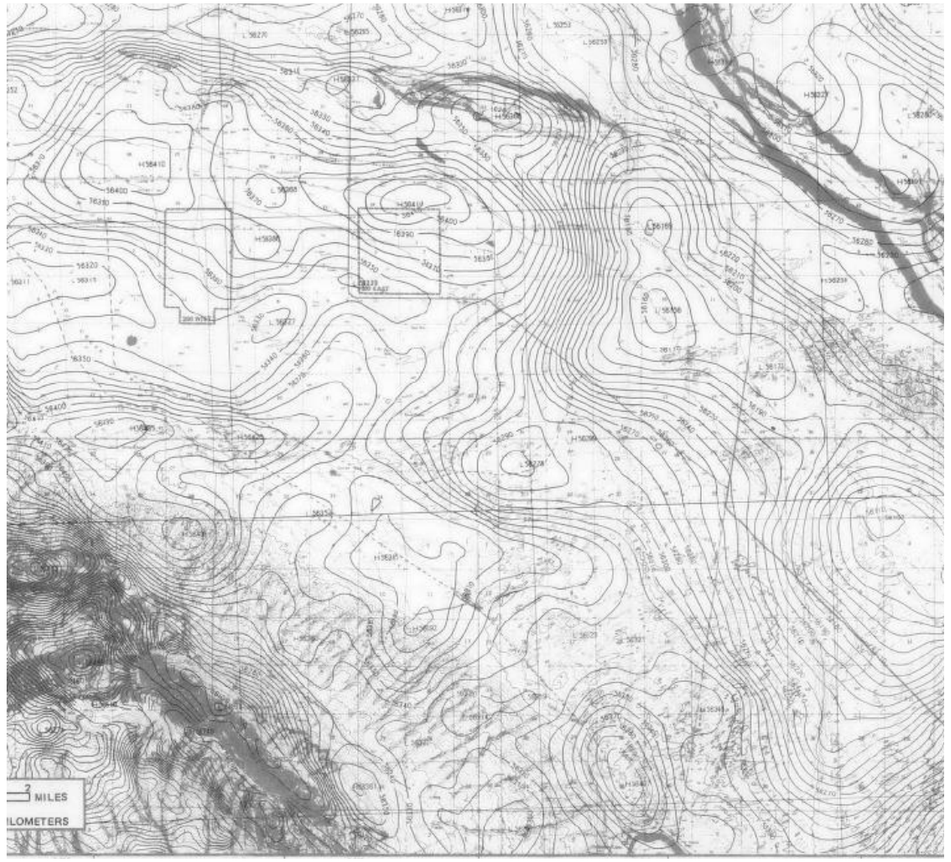
Aeromagnetic Field Contour Maps

760 m

1,220 m



One of the first data outputs of the aeromagnetic survey raw data

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Magnetic Interpretation of Deconvolution Solutions

- Magnetic surveys produced an approximate depth and dip of dikes and structures (e.g. fault zones) on Hanford
- Multiple-source Werner deconvolution was the depth-estimation method that was used for 2D bodies (1983)
- Had the advantage of being easily programmed on a digital computer
- Evolved into the basis of the automatic interpretation schemes.
- By 1993 a 3D methodology was developed.

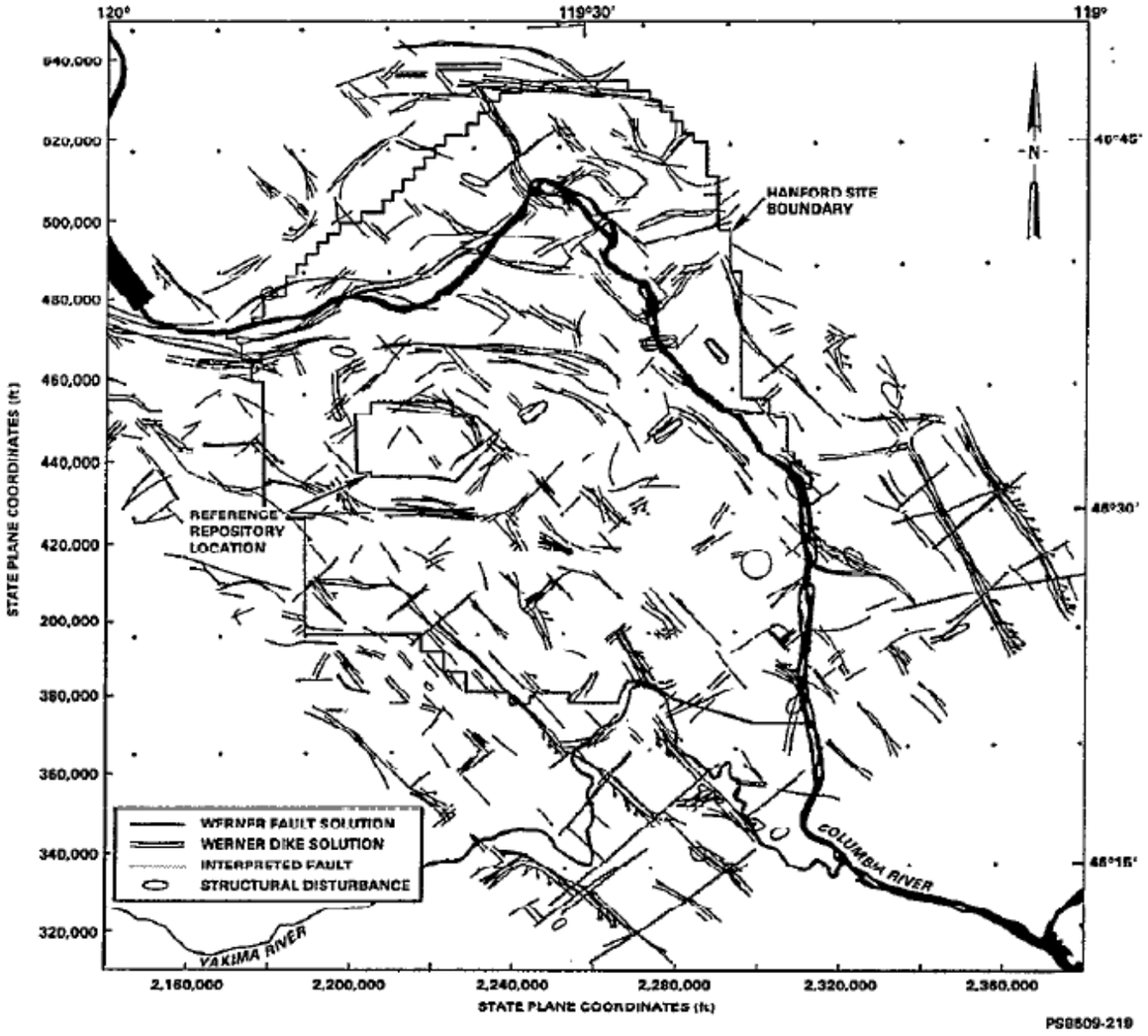

Figure 1.3-32. Summary of Werner deconvolution solutions for aeromagnetic survey data (AERO, 1980).

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Ground-based Magnetics and Vertical Electrical Soundings (VES)

Focused on stratigraphic boundary interpretations near Gable Gap

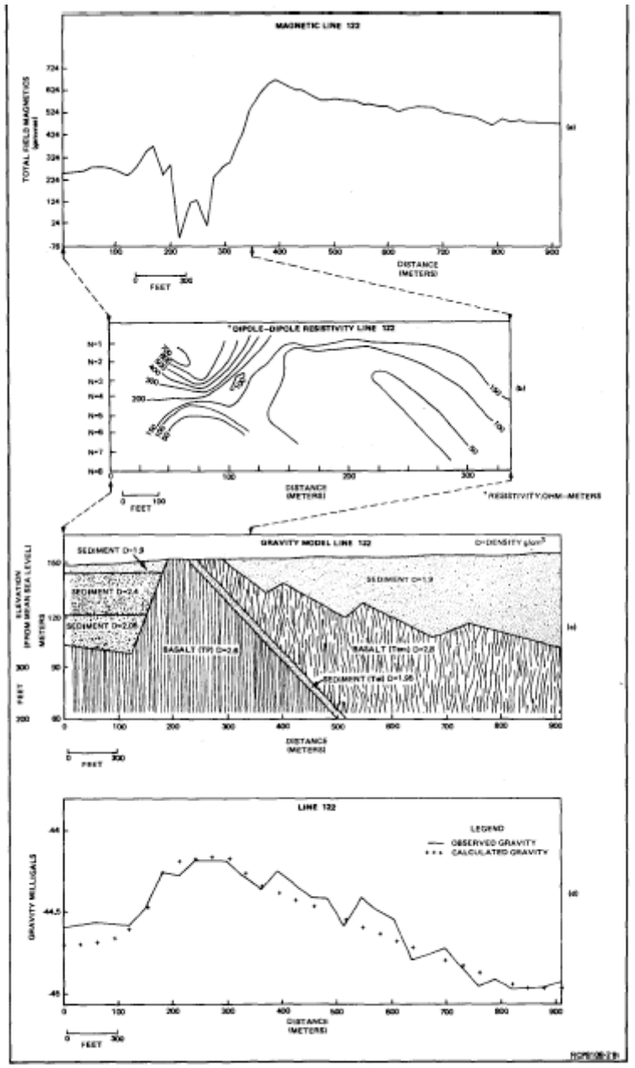
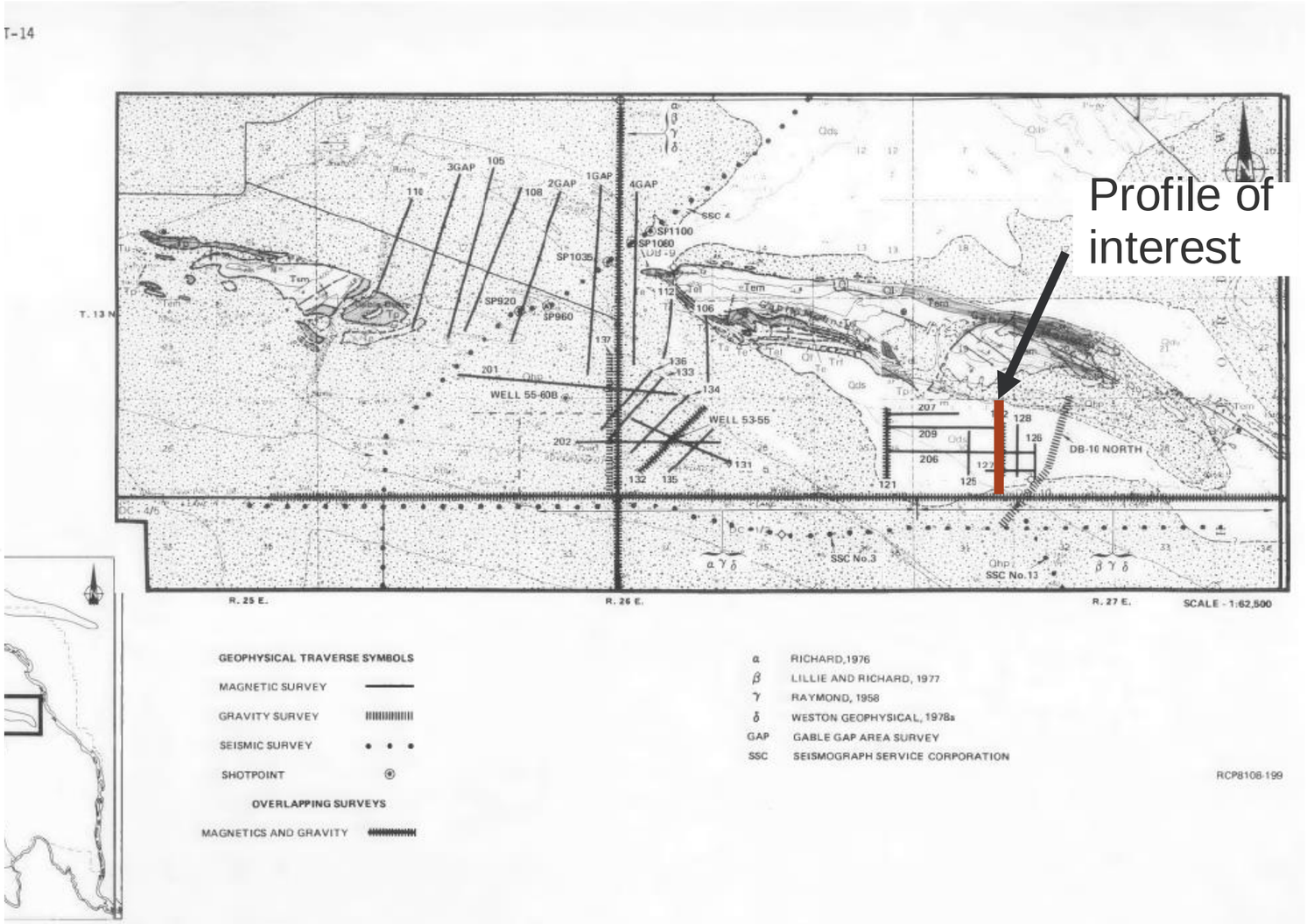


FIGURE D-12. DB-10 Area Surveys, Line 122.

D-14



ıntain-Gable Butte Survey Areas (see Table 3-1 for explanation).

D-2

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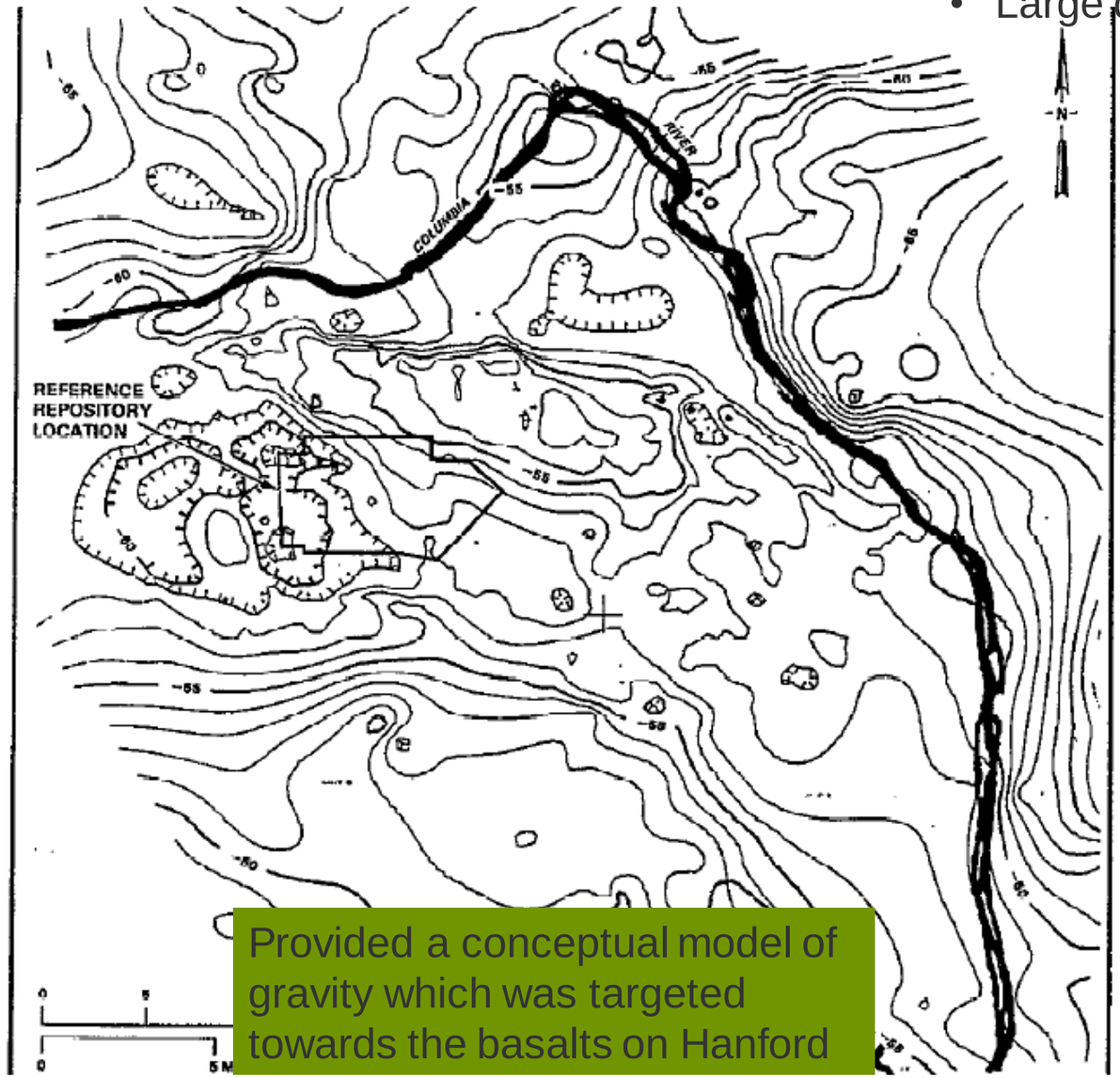
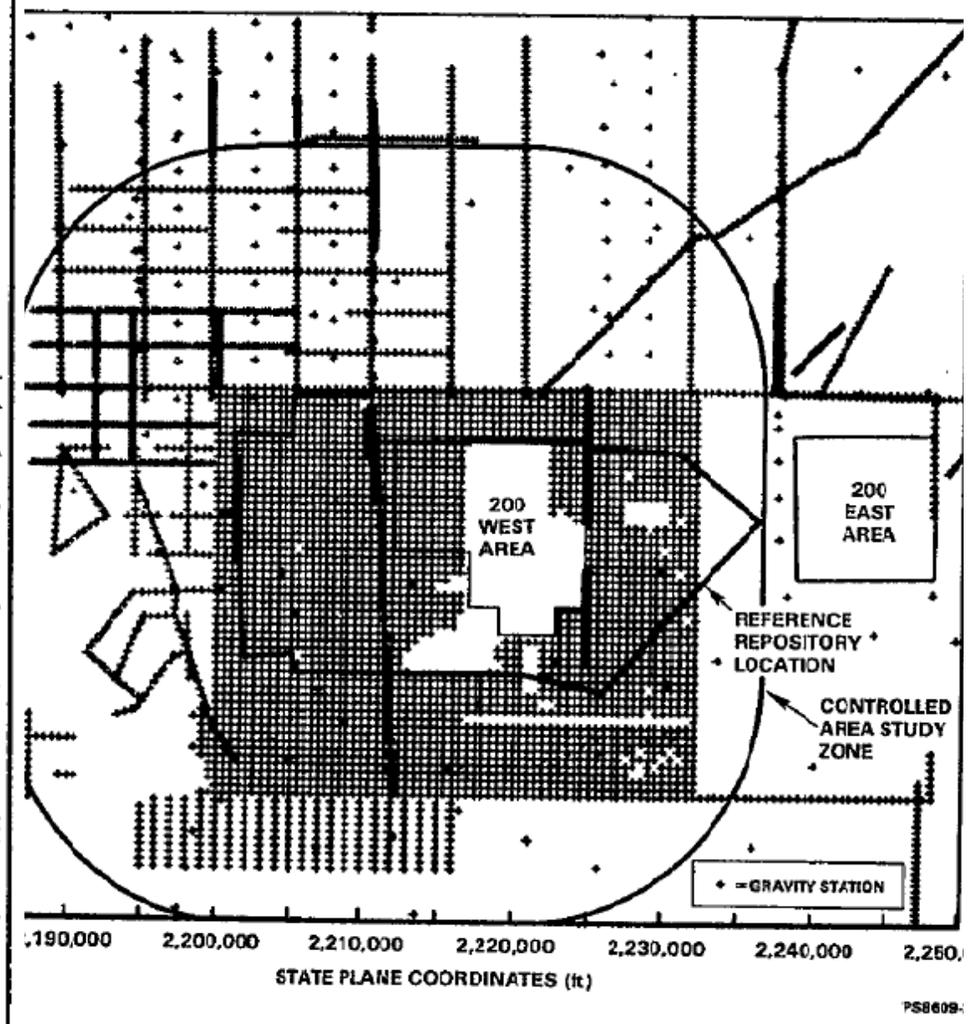
Gravity Surveys

- Provides information about the densities of rock
- Gravity stations in the Reference Repository Location
- Large density of gravity stations





Provided a conceptual model of gravity which was targeted towards the basalts on Hanford

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Geophysical Data from Washington State University

BNWL-47

UC-51, Geology and Mineralogy
(TID-4500, 40th Ed.)

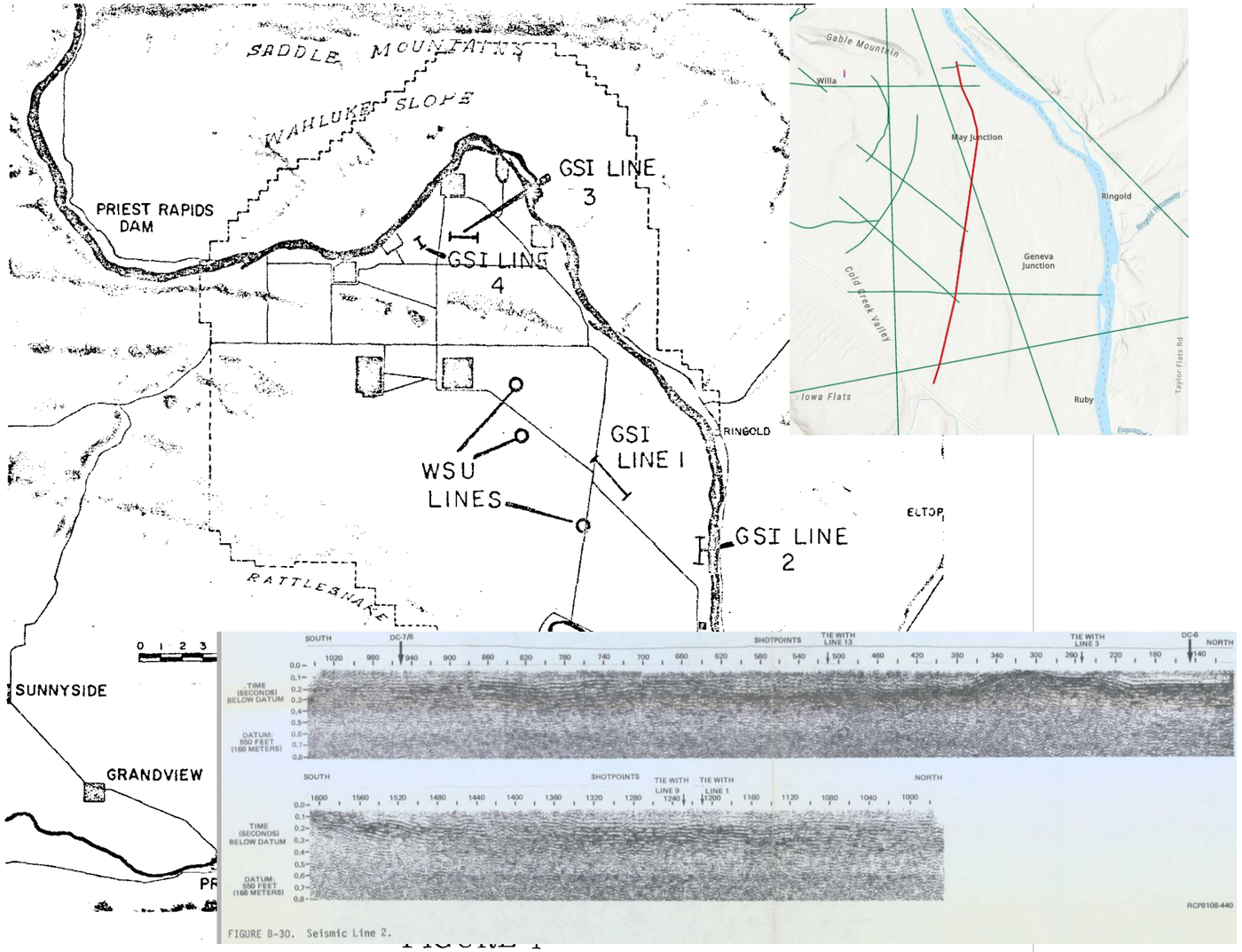
GEOPHYSICAL SEISMIC EVALUATION STUDY AT HANFORD

By

R. E. Brown
J. R. Raymond

Chemistry
Chemical Effluents Technology

December, 1964



Index Map Showing the Location of the Geophysical Service, Inc. and Washington State University Seismic Lines

WSU repository has geophysical data for the entire state of Washington including Hanford (dating back to the 1960s) and is Web GIS based.

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The Good Old Days

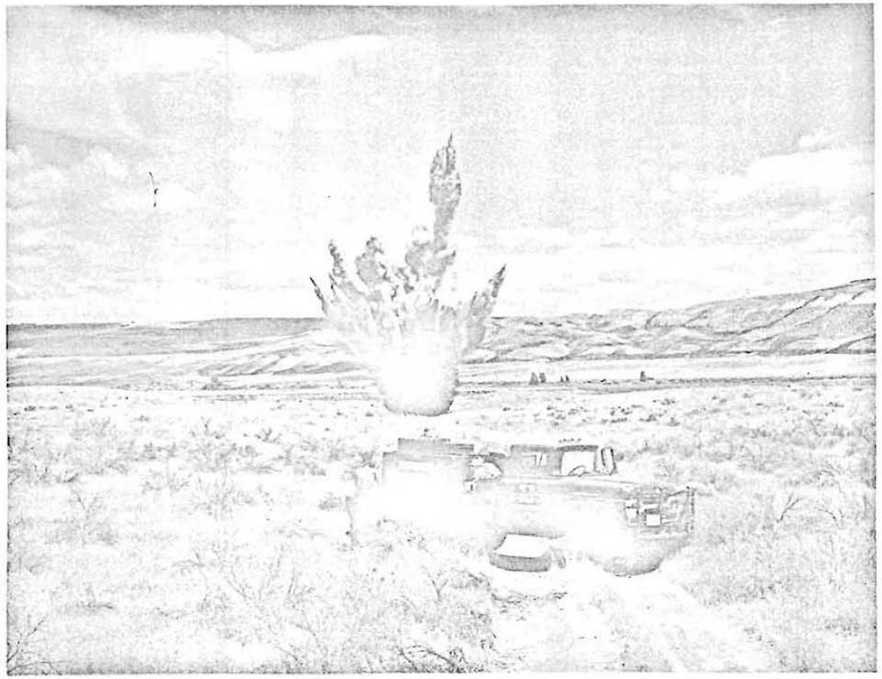

FIGURE 3

Near-Surface Detonation of 100 lb Nitramon Charge

Summary

- Hanford is a complex remediation site because of the legacy processes and associated waste sites
- Geophysical methods have historically been used on the Hanford Site extensively, but there have been technical limitations
- Implementation of newer processing and data acquisition efficiencies is aiding in the utility of geophysics on the Hanford Site
  - Newer processing of old datasets presents an opportunity for additional site characterization without the cost of data acquisition

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Thank you!

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References

- 1940's Seismic for geotechnical information for sighting the chemical separations plants, referred to as the "Canyons"
  - DDTS-433, Preliminary Geological Report Gable Site, January 28, 1943.
  - DDTS-Generated-435, Final Report, Gable Project Exploration, April 14, 1943

- Basalt Waste Isolation Project (BWIP) Geologic repository
  - DOE/RW-0164, Consultation Draft, Site Characterization Plan, Reference Repository Location, Hanford Site, Washington, Vol. 1, and PNNL- 13149, Review of Geophysical Characterization Methods Used at the Hanford Site
  - Consultation Draft, Site Characterization Plan volumes 1-8 NRC site https://www.nrc.gov/docs/ML0901/

- Geophysical data from Washington State University
  - Geophysical Seismic evaluation study at Hanford, BNWL-47, 1964, Brown, R.E., and J.R. Raymond.
  - https://washingtonstategeology.wordpress.com/2023/05/10/a-new-way-to-easily-explore-and-access-geophysical-data-for-washington-state/
  - **DNR webpage**
  - https://www.dnr.wa.gov/programs-and-services/geology/publications-and-data/gis-data-and-databases