A Geological and Geophysical Assessment of the Royal Center Gas Storage Field in North-Central Indiana, a Joint NIPSCO, DOE & GRI Case Study

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by

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- An effort to evaluate the Royal Center Storage Field was initiated to determine the feasibility of utilizing horizontal well technology to improve the ratio of working gas to base gas and improve deliverability. The geophysical survey and interpretation was initiated by GRI and the geological modeling and reservoir analysis is being accomplished through a Cooperative Research And Development Agreement (CRADA) between Northern Indiana Power Supply Company and U.S. DOE Federal EnergyTechnology Center.

- An integrated analysis of well logs, core data, and seismic survey data was applied to the Royal Center Storage Field in the Trenton Limestone aquifer. The field is a structural closure that strikes northeast with a parallel fault on the southeast boundary. The porosity appears to be a combination of dolomitization and fracturing in the structural high of the asymmetric anticline. Core permeability data was compared to Epilog calculated porosity and gas saturations. The data shows very complex relationships exist when compared in three dimensions.

- A correlation of seismic amplitude anomalies with the porosity and gas saturation on cross sections was also used to evaluate potential well sites. A downhole seismic survey was then run to determine if the amplitude anomalies from the surface seismic survey could be detected and their orientations calculated to assist in designing the horizontal well. The integrated results from all of the studies were used to site a horizontal well in the northern portion of the field.

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Northern Indiana Public Service Company
CRADA Research Project

Goals:

- Original plans were to use 2-D and swath seismic techniques to determine if cushion gas occured in the western limits of the aquifer storage structure and if it was associated with fractures.

- Determine fracture orientations using 3-D geologic modeling and well log analysis.

- Integrate all of the data to determine the best location for a horizontal well to access the cushion gas in the western portion of the reservoir and increase the working gas ratio.

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Northern Indiana Public Service Company
CRADA Research Project

Partners:

- NIPSCO provided information on all of the well data on the Royal Center Gas Storage Field in north central Indiana and drilled a horizontal well as a result of the integration of the data from the other partners.

- DOE provided 3-D geologic modeling, modified VSP in offset wells and integration of the well and geologic data to determine if correlations existed to define fractures in the reservoir. Reservoir modeling was also applied and supported the interpretation that the reservoir was complex.

- Gas Research Institute provided cofunding to obtain seismic data across the field to determine if 2-D seismic methods could be used to detect fracturing in the Trenton Limestone reservoir.

- Polaris Energy was subcontracted to obtain the seismic data and provide the interpretation of amplitude anomalies with respect to the well log data and geologic interpretations.

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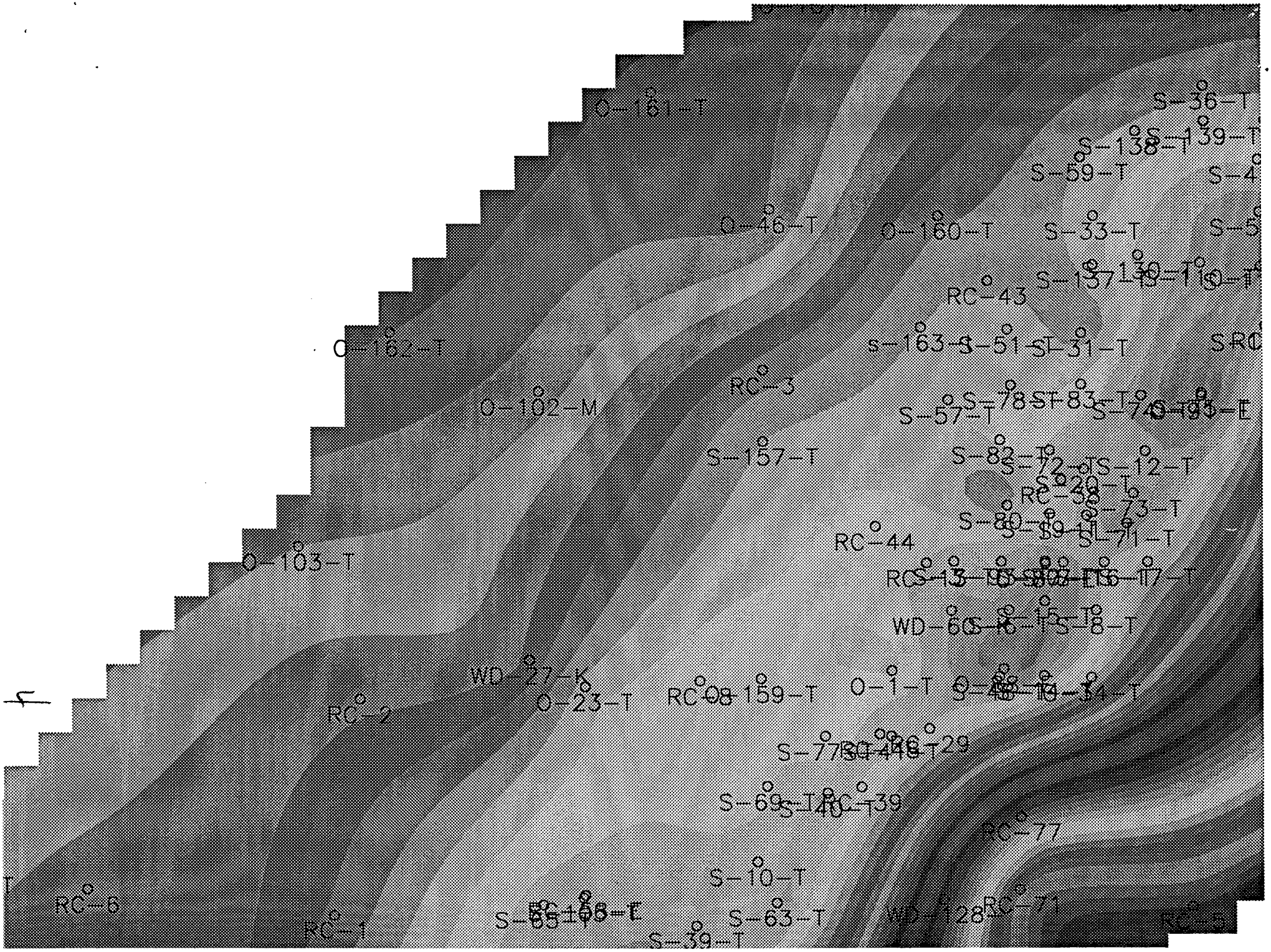
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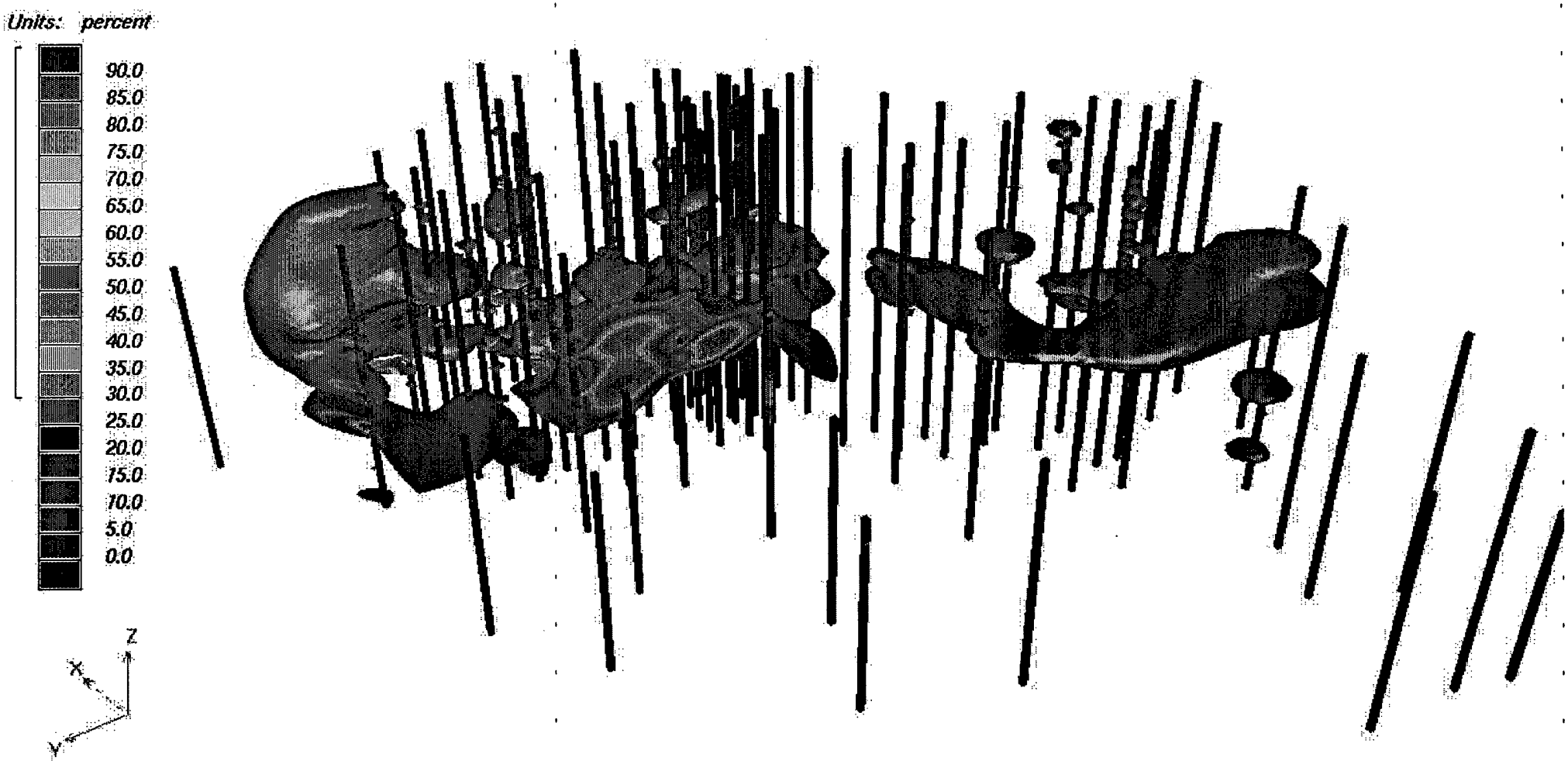
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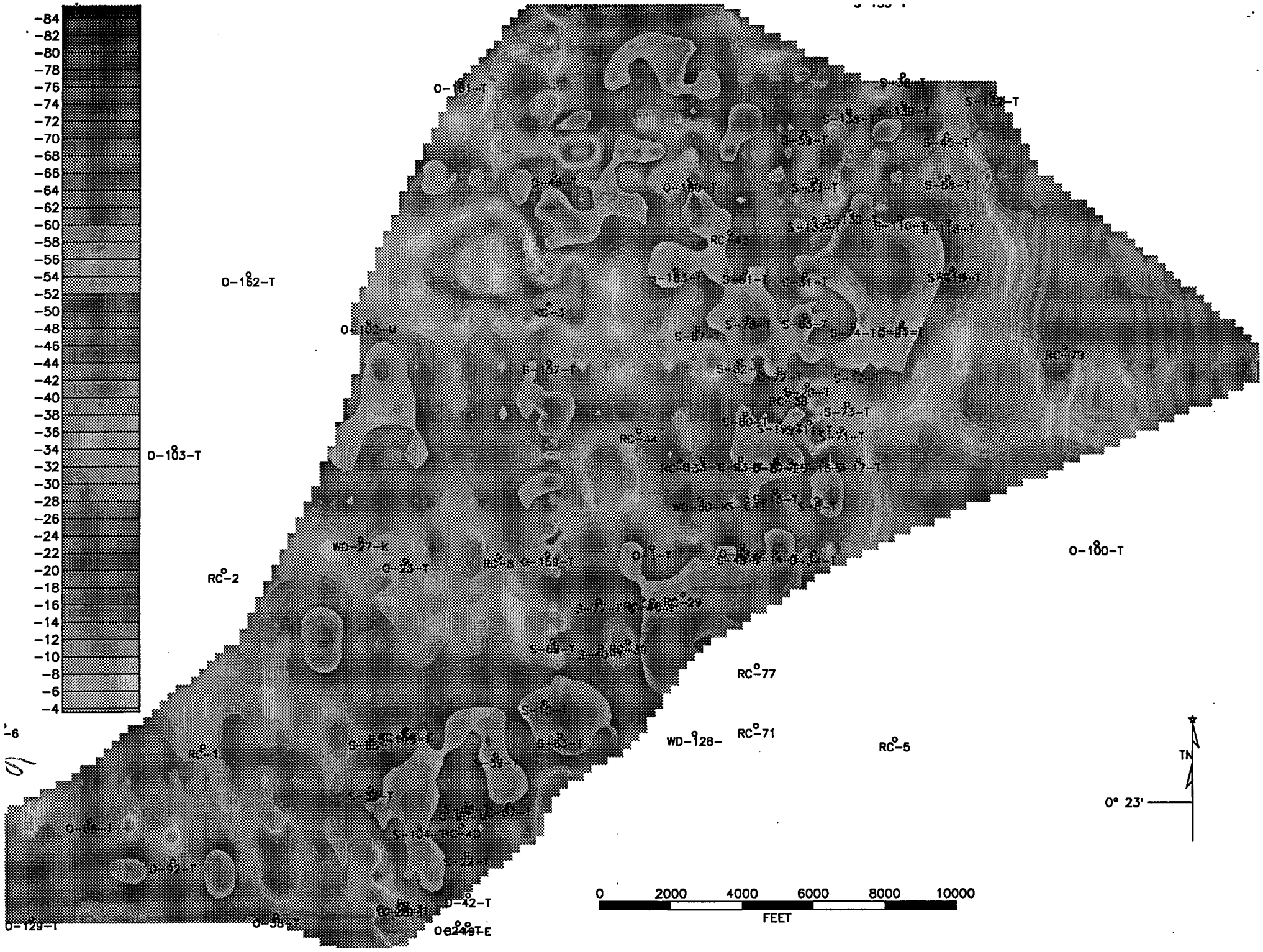
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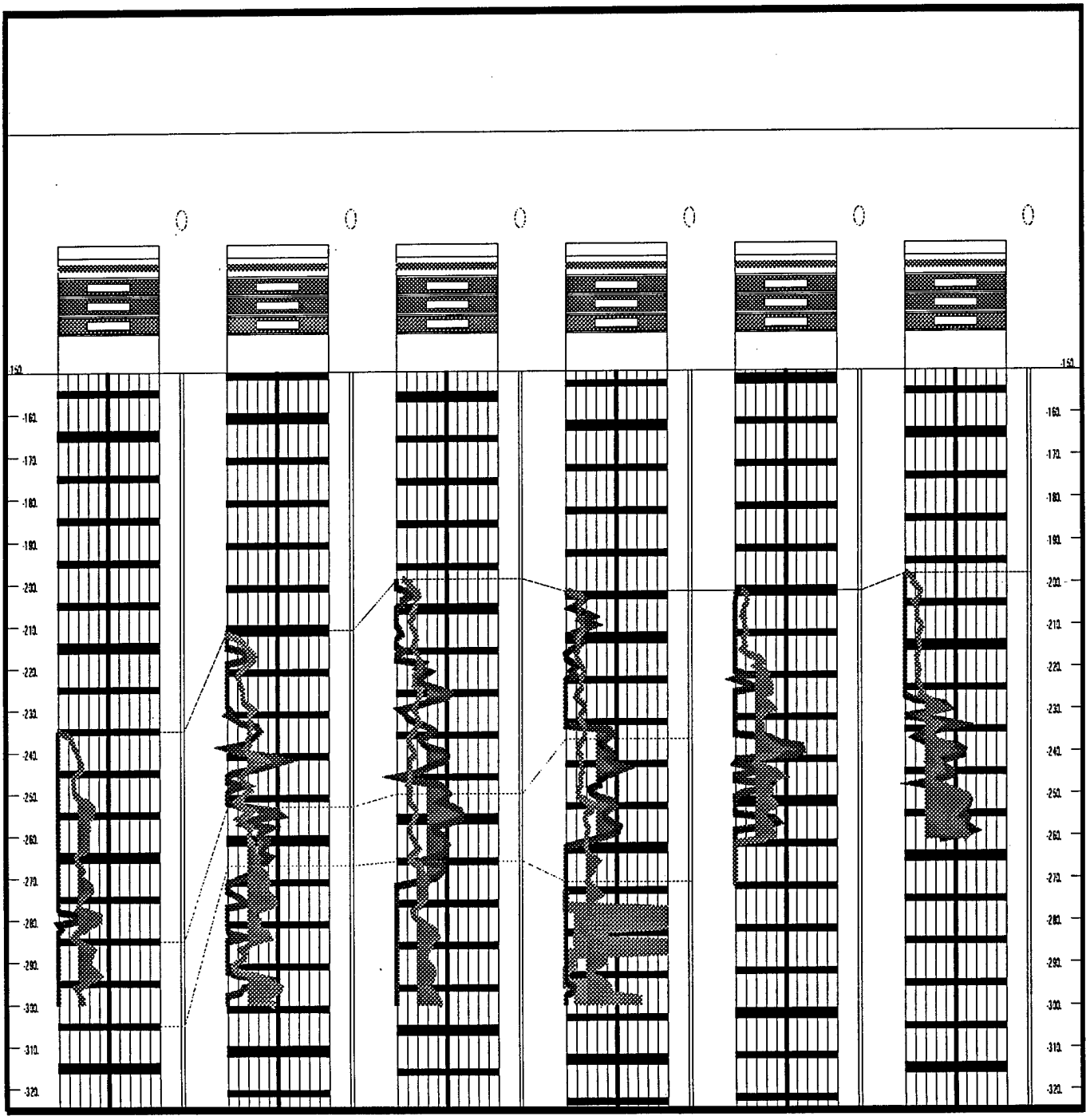
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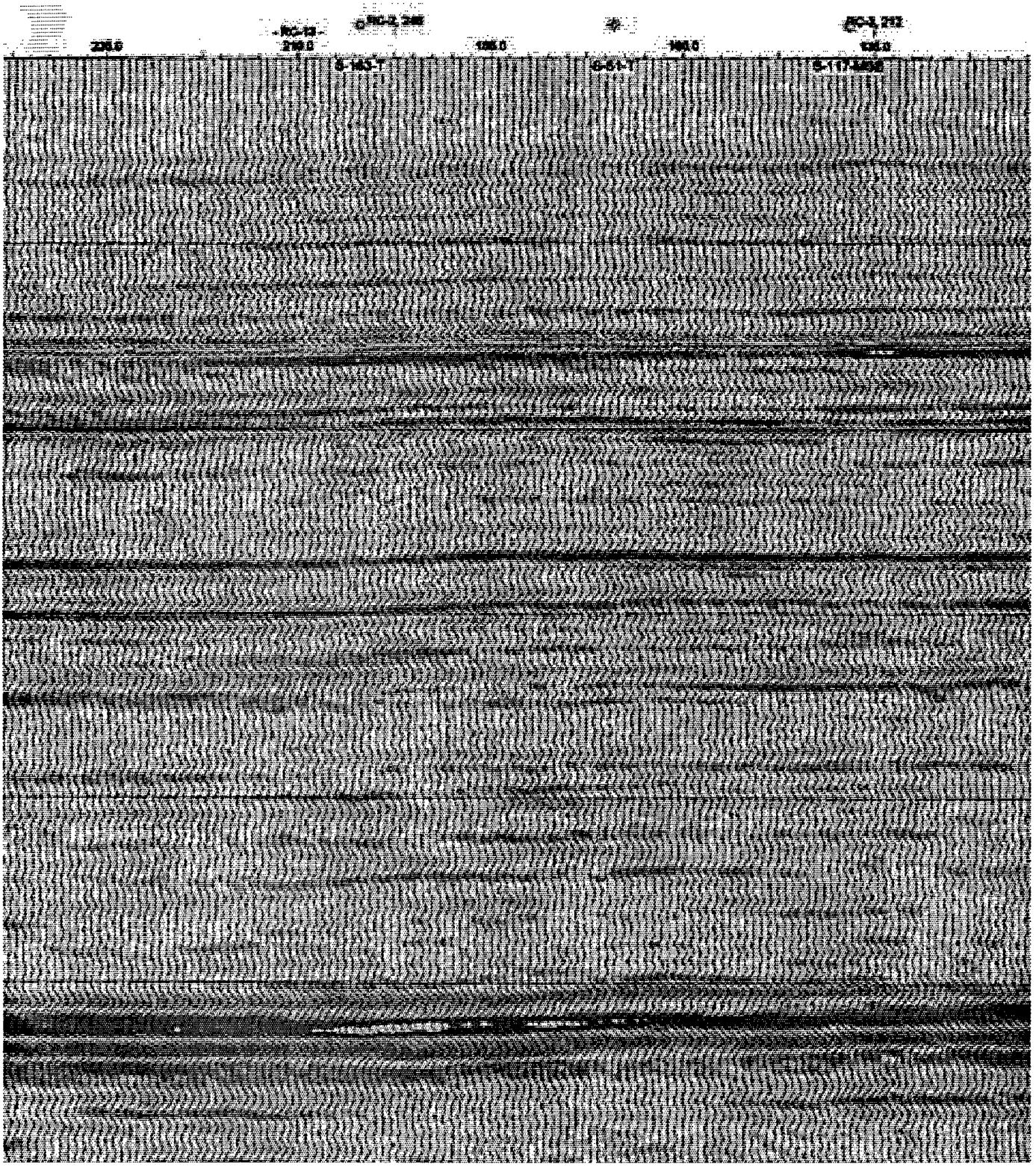

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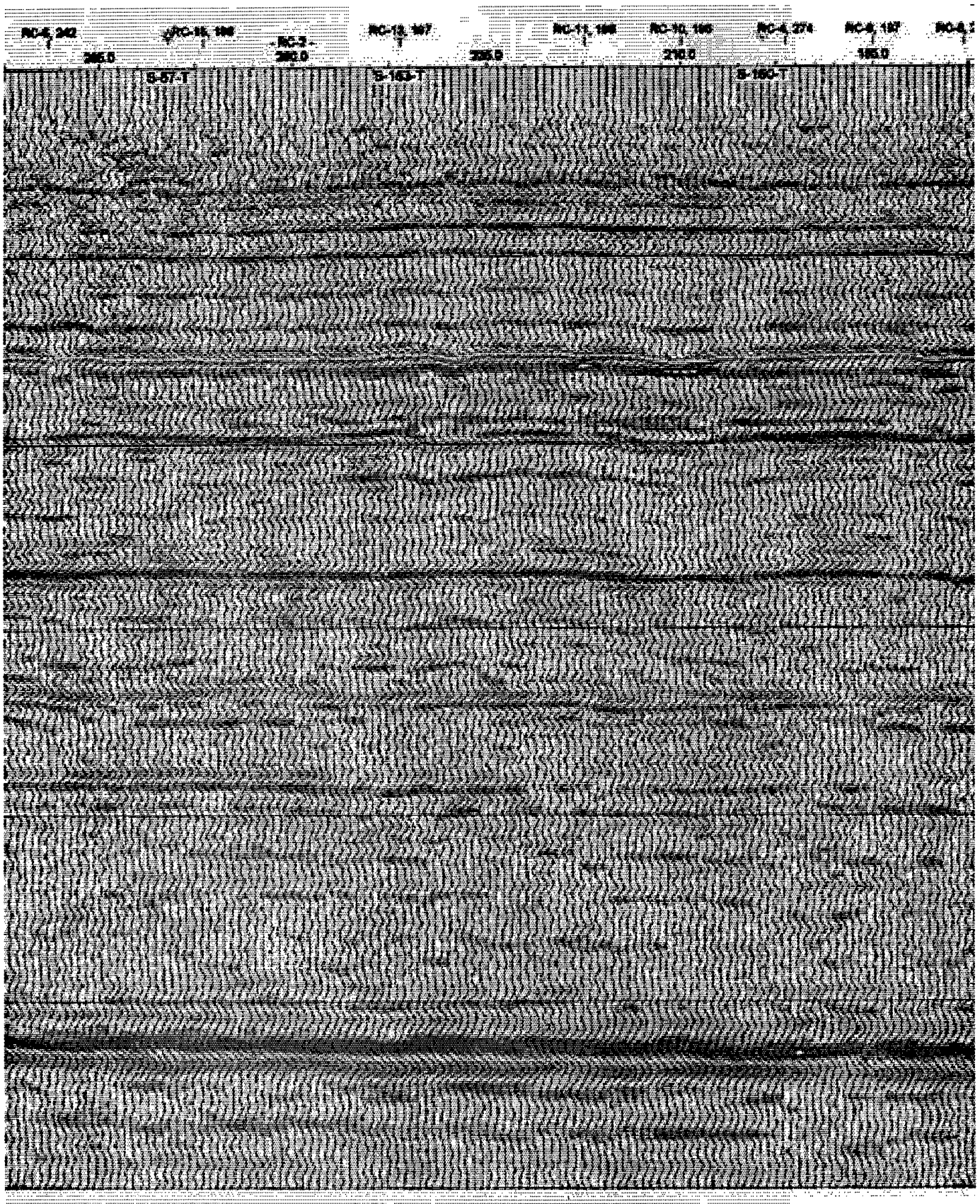
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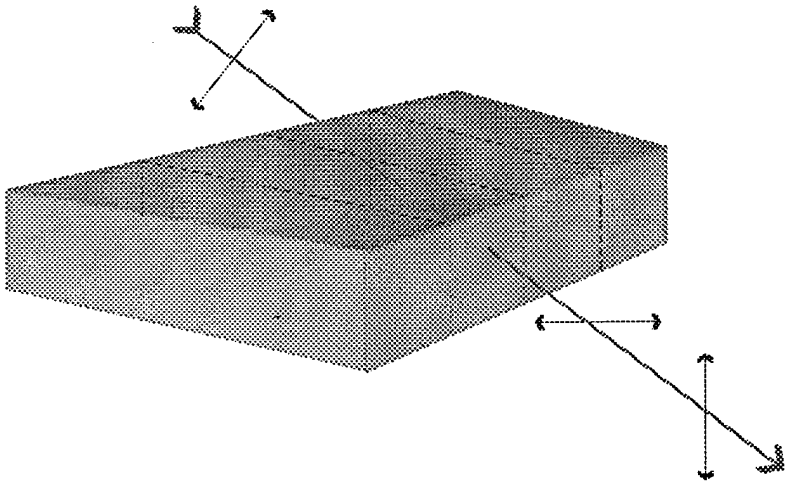
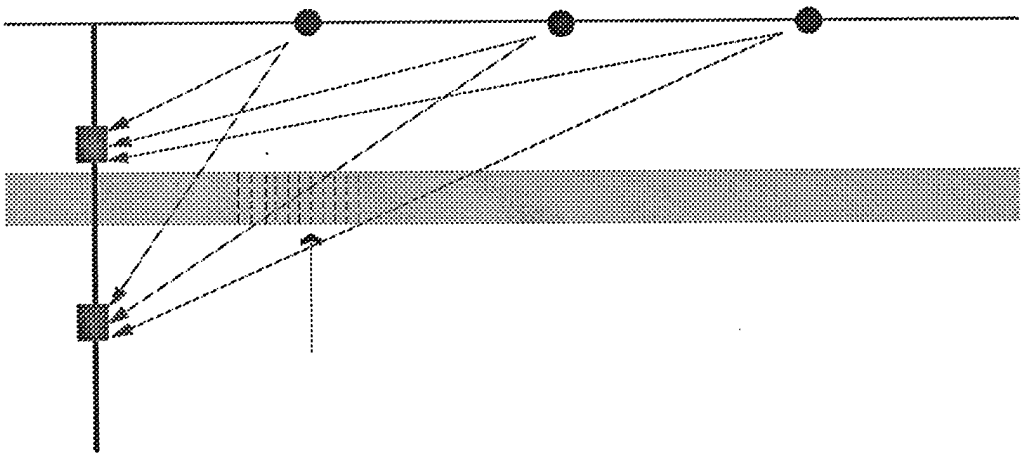
NIPSCO VSP Experiment

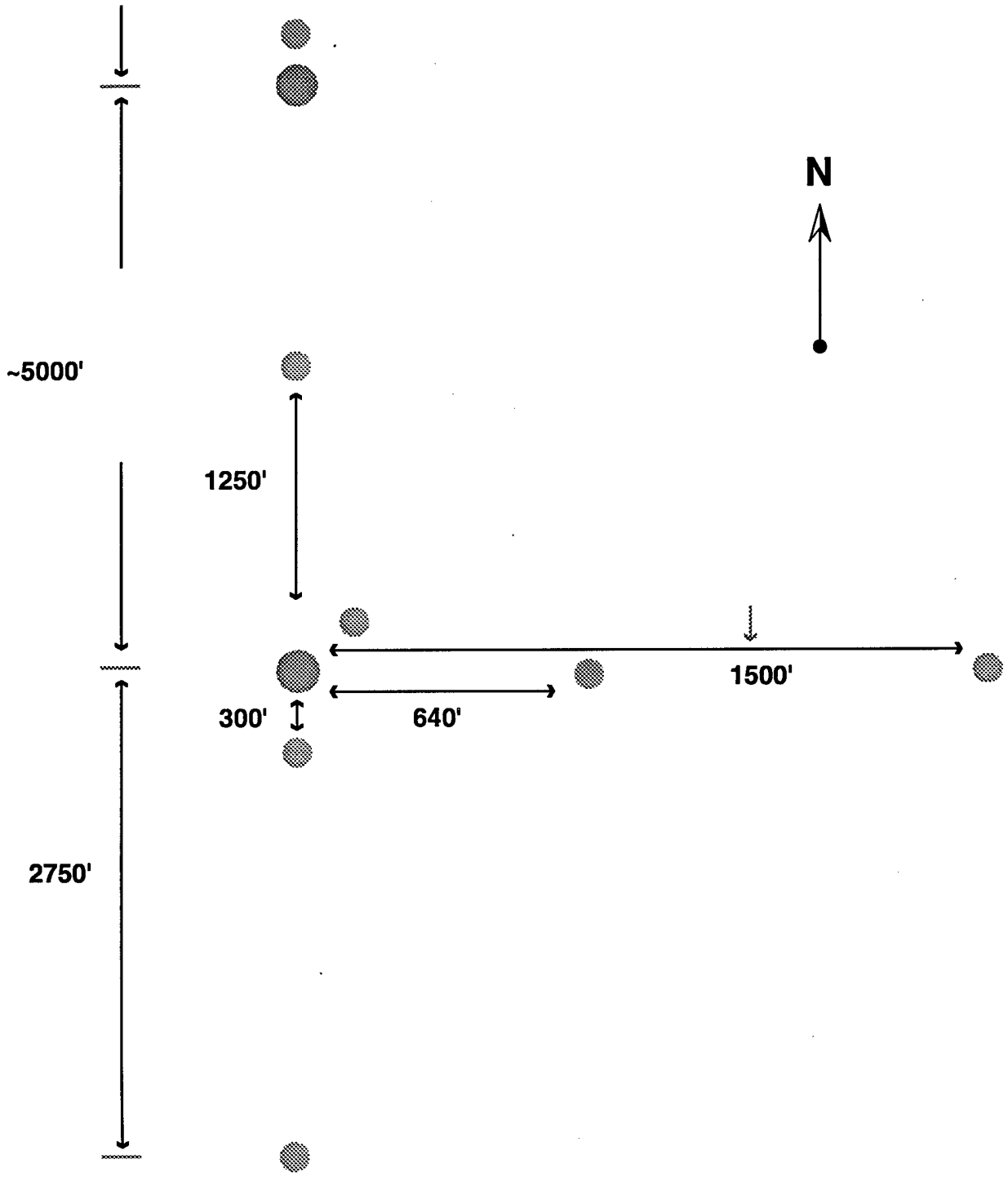
Objective 1: **Determine fracture orientation from s-wave splitting.**



Objective 2: **Estimate fracture location from winter/summer changes in P & S wave attributes**



NIPSCO VSP Source Locations



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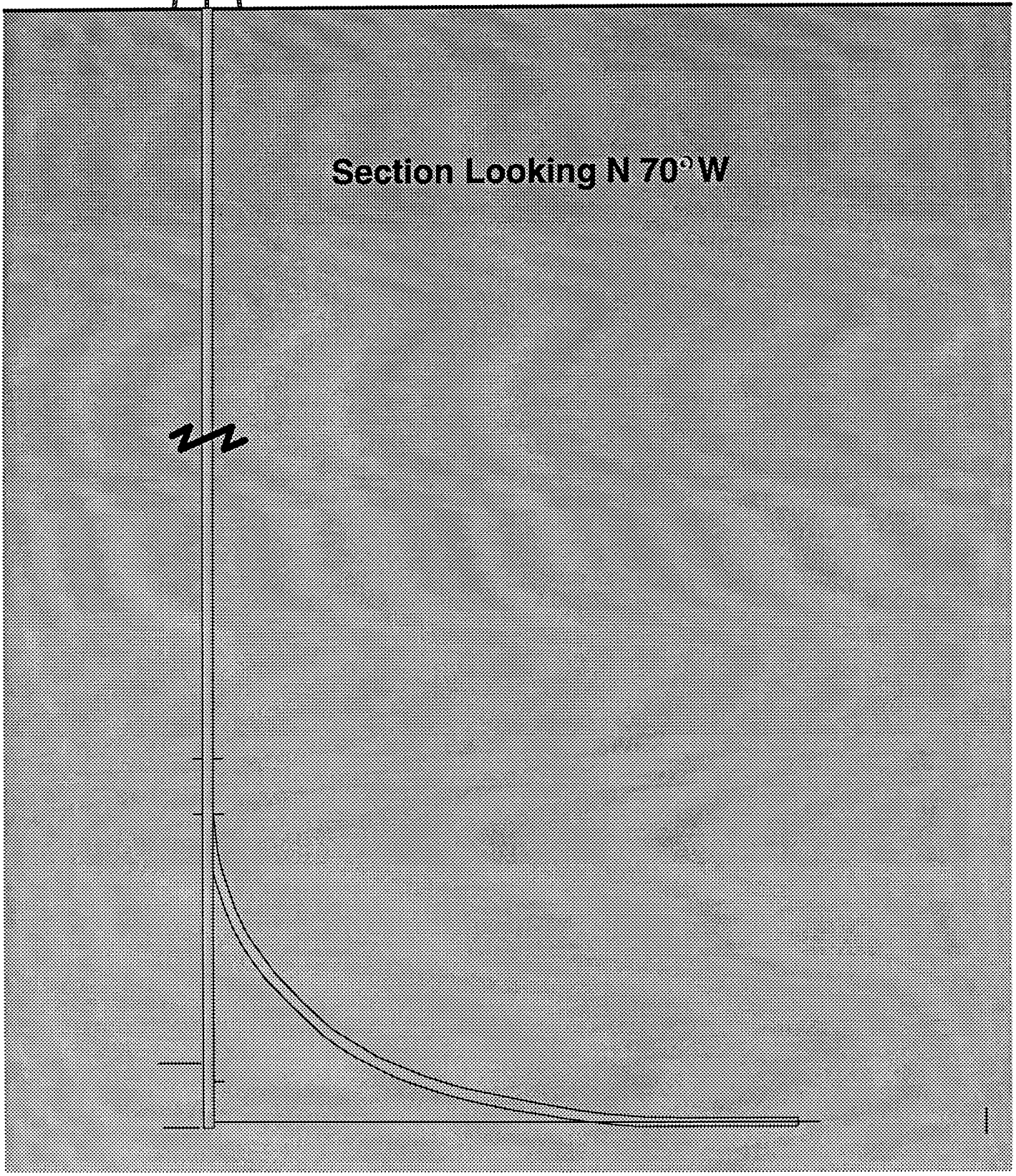
NIPSCO

Horizontal Well 163-T



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Results:

- Well log analysis and 3-D geologic mapping indicated fracturing and gas saturations above Trenton Limestone dolomitized porosity.
- 2-D seismic amplitude analysis indicated zones and trends of gas filled porosity and fractures.
- Preliminary results of VSP P and S wave seismic surveys in offset wells indicated fracturing in the top of the Trenton Limestone.
- The horizontal well successfully intersected high porosity and gas saturations in the reservoir west of the main storage reservoir.

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