

THAI WASTE MANAGEMENT WORKSHOP 1

HYDROGEOLOGY



THAI WASTE MANAGEMENT WORKSHOP 1, HYDROGEOLOGY
AECL, WHITESHELL LABORATORIES, PINAWA MB CANADA

HYDROGEOLOGICAL ASPECTS:

- *HOST AREA SCREENING*
- *POTENTIAL CANDIDATE AREA EVALUATION*
- *CANDIDATE AREA CHARACTERIZATION*
- *FAVOURABLE CANDIDATE SITE CHARACTERISTICS*
- *CANDIDATE SITE CHARACTERIZATION*
- *RESEARCH AND DEVELOPMENT*



HOST AREA SCREENING

PREREQUISITES: *environmentally safe and publicly acceptable*

STRATEGY: *use an investigative method that will ultimately locate a preferred repository site (4km²) that is publicly acceptable, provided that ongoing investigations show that the site is environmentally safe.*

PROCEDURE:

- *form a host area screening group (consisting of: a senior member of each of the scientific disciplines involved through the contractor in the “host area screening” (geology, geophysics; hydrogeology); a representative from each of the host communities; a representative from the utility company funding the screening;*
- *apply exclusionary / inclusionary screens to locate host areas (>1000 km²) near adjacent potential host communities; select, evaluate and characterize a candidate area within each of 2 or 3 host areas; select a preferred candidate site (25 km²) within the evaluated candidate areas with public participation; characterize the candidate sites; select a preferred repository site with public participation*



PROCEDURE FOR CONSTRUCTING THE REVISED CONCEPTUAL HYDROGEOLOGICAL MODEL

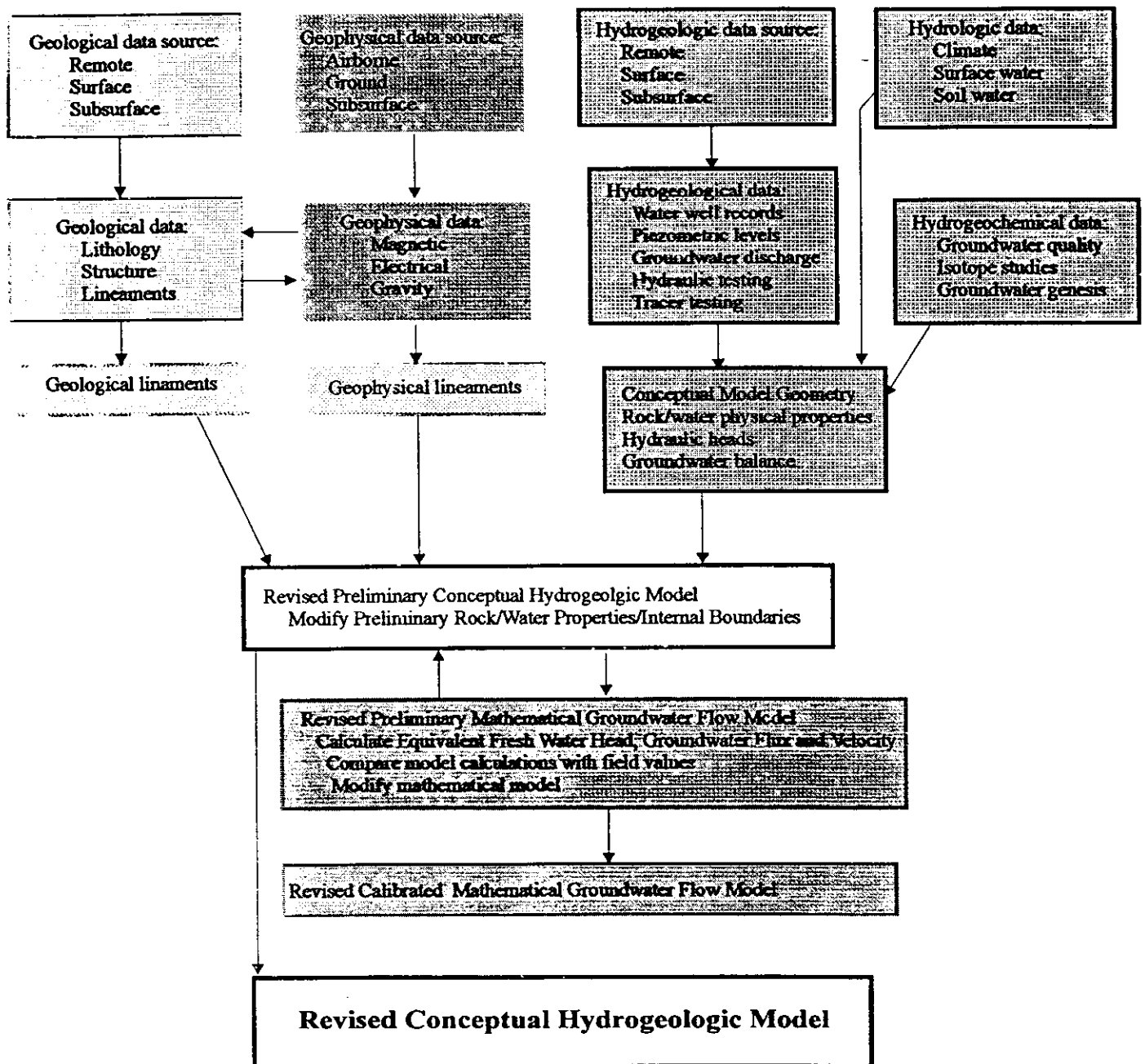
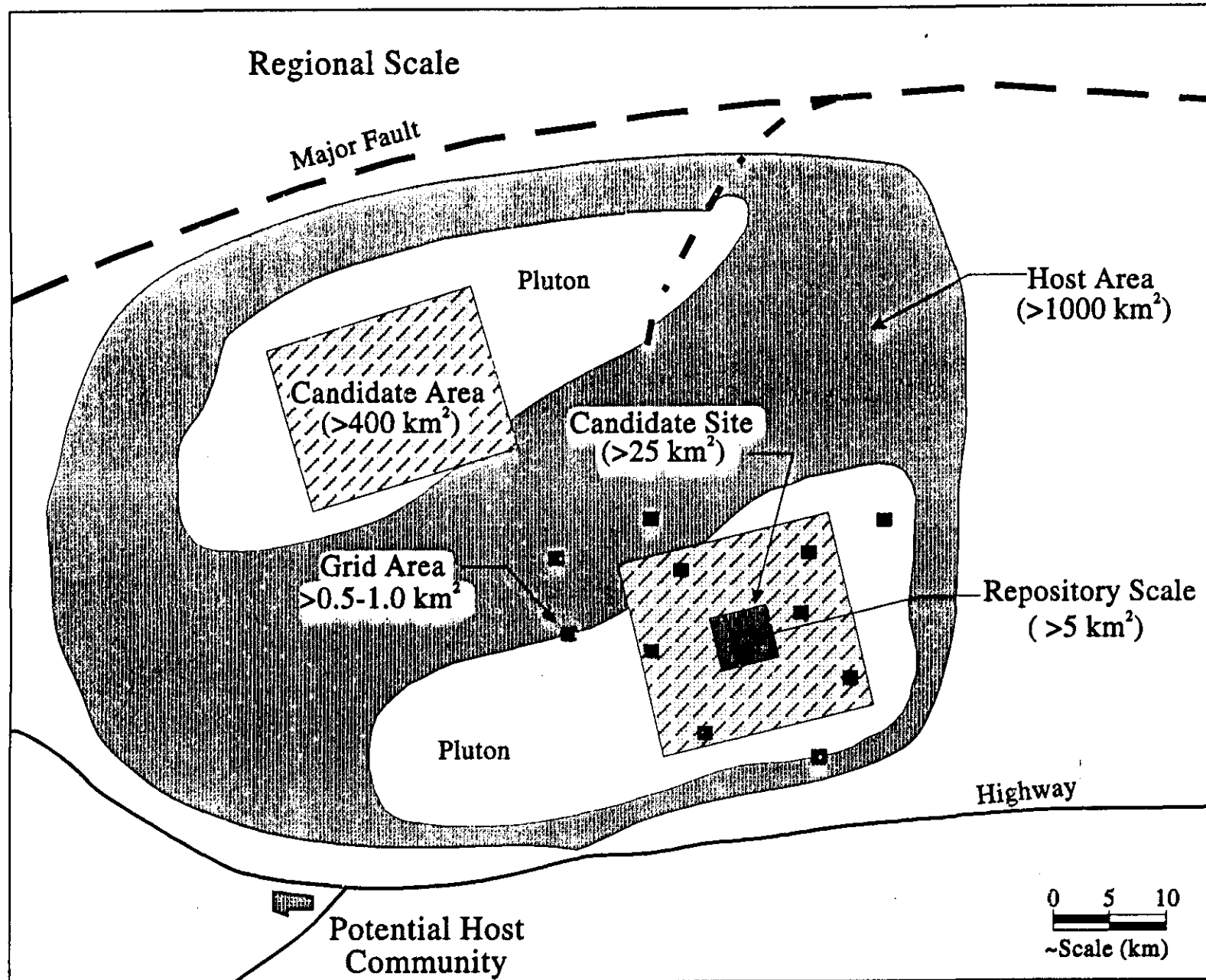


Figure 1: Procedure for constructing the revised conceptual hydrogeological model

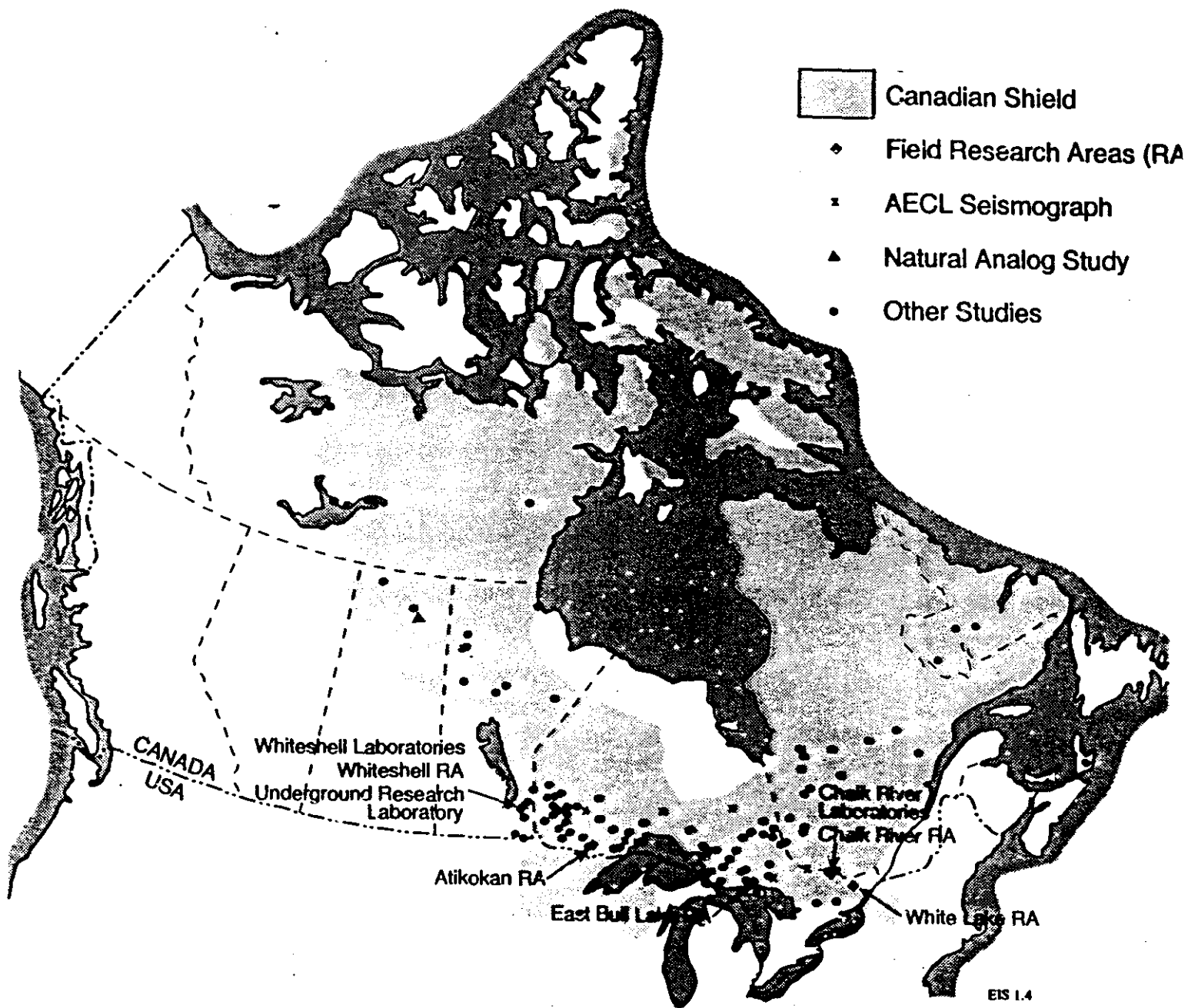
Scales of Investigation during Siting

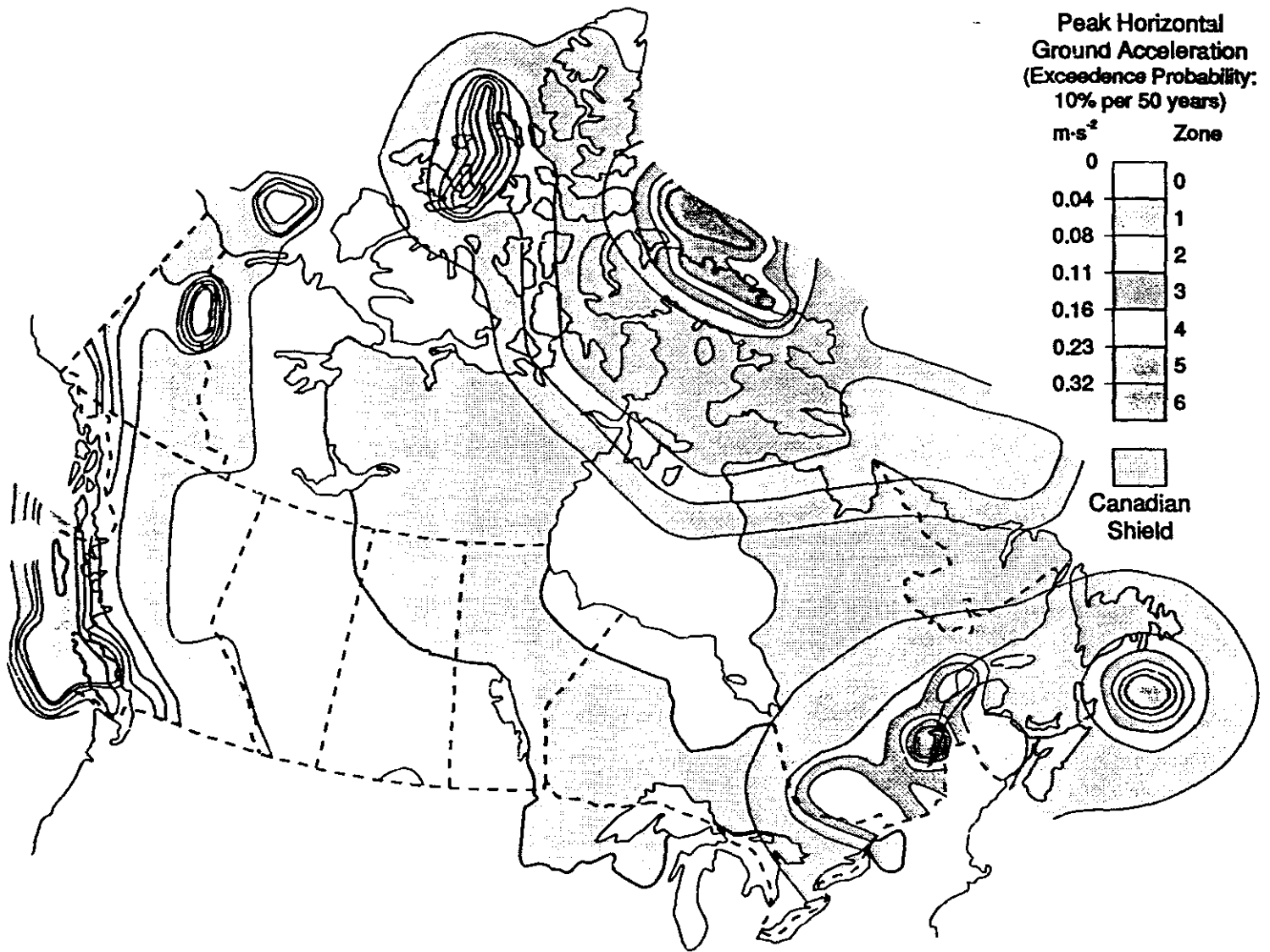


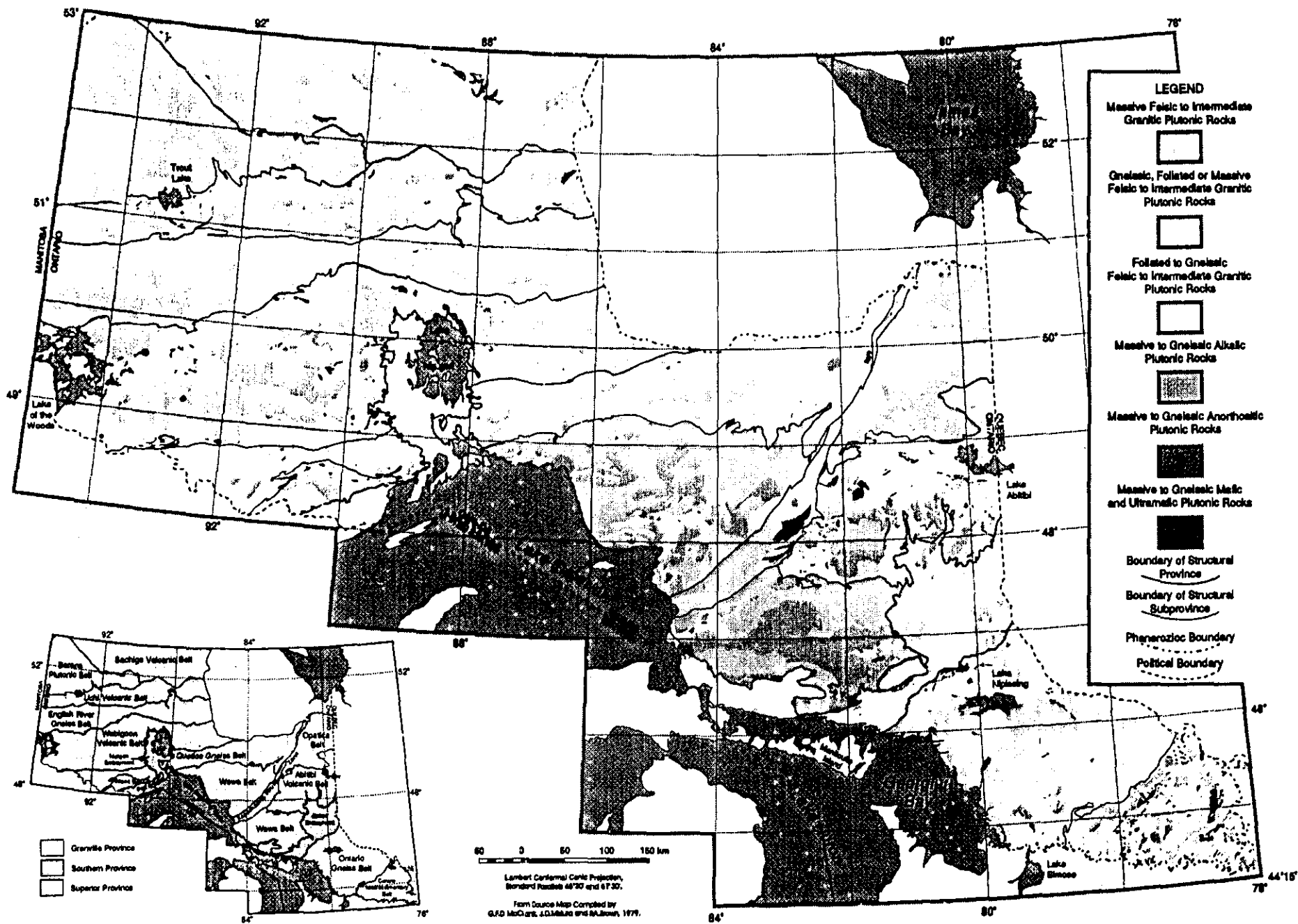
EXCLUSIONARY / INCLUSIONARY HYDROGEOLOGIC CRITERIA

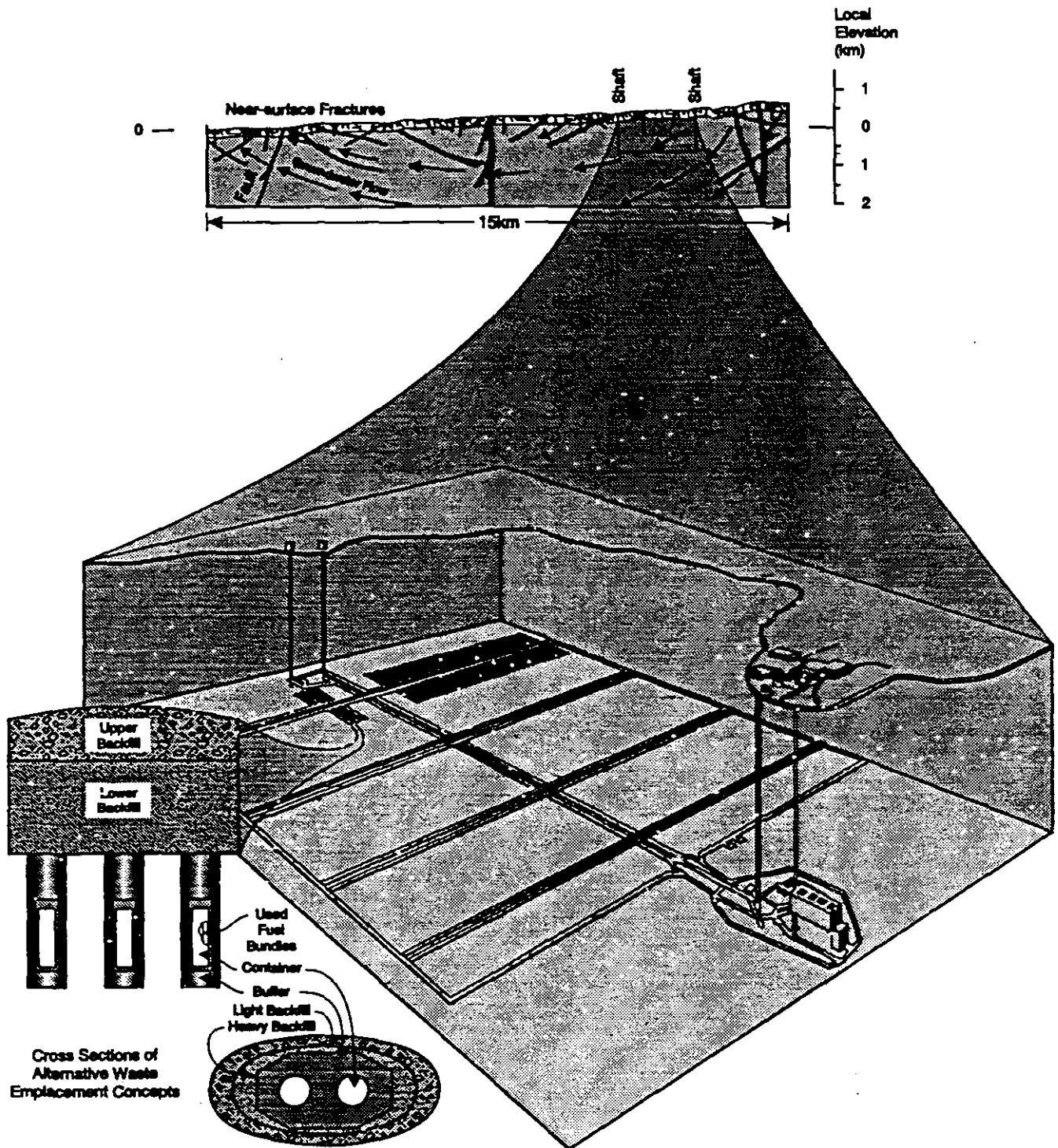
- ROCK TYPE: *IN PLUTONIC ROCK IN THE CANADIAN SHIELD*
- GEOLOGICALLY STABILITY REGION: *LOW SEISMIC RISK (low peak horizontal ground acceleration);*
- IN LARGE PLUTON FAR FROM MINING REGIONS OR ECONOMIC MINERAL DEPOSITS
- TOPOGRAPHIC POSITION: *IN WELL-DRAINED UPLAND (in potential groundwater recharge area with long groundwater flow paths)*











HYDROGEOLOGICAL ASPECTS:

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- *RESEARCH AND DEVELOPMENT*



POTENTIAL CANDIDATE AREA EVALUATION

- *HYDROGEOLOGIC ENVIRONMENT AND
GROUNDWATER REGIME*
- *HYDROGEOLOGIC MODELLING CONCEPTS*
- *HYDROGEOLOGIC MAPPING (regional scale)*
- *CANDIDATE AREA SELECTION*



HYDROGEOLOGIC ENVIRONMENT AND GROUNDWATER REGIME

CONCEPTS:

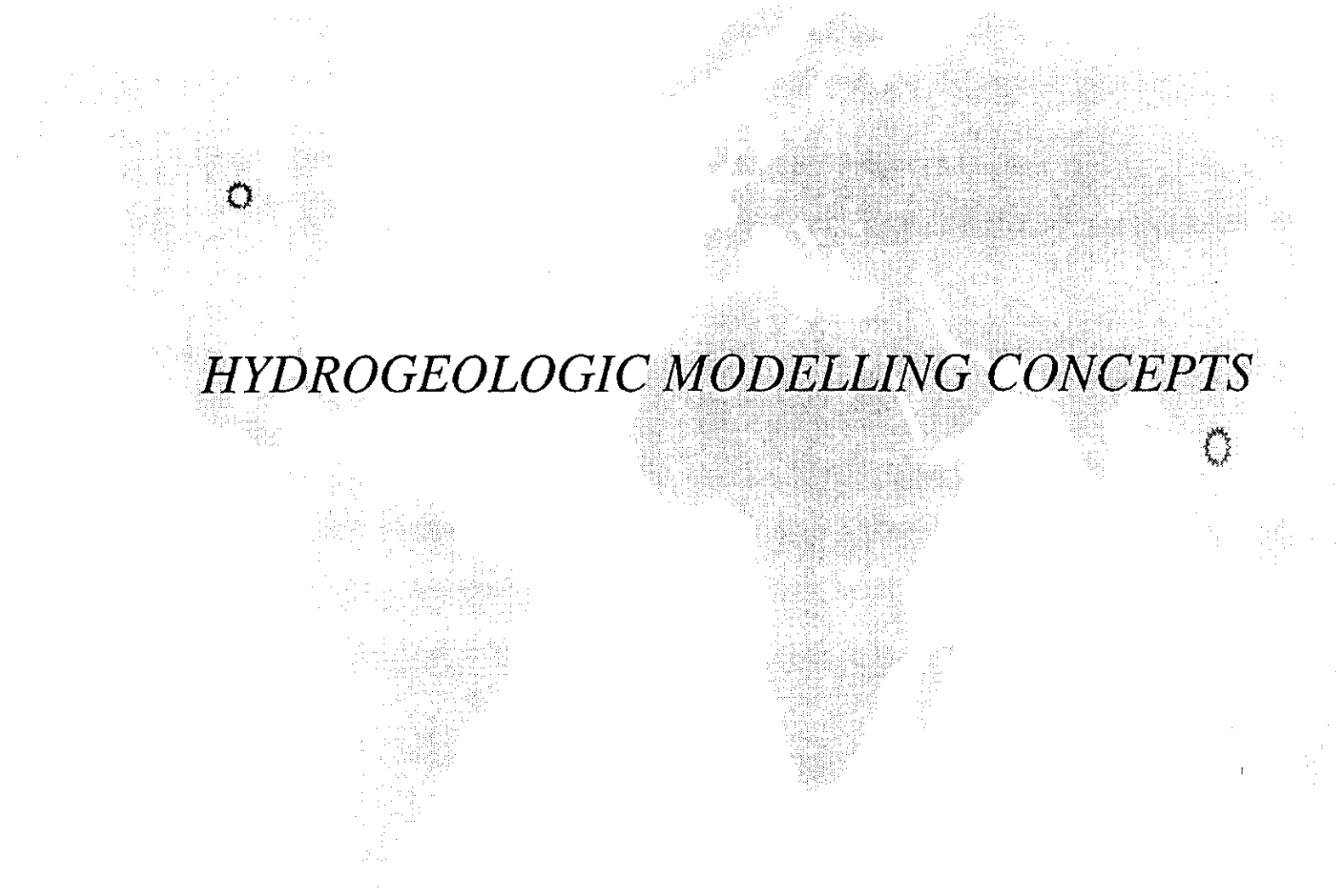
DESCRIBE THE HYDROGEOLOGIC ENVIRONMENT:

- *GEOLOGY: MAJOR STRUCTURAL FEATURES / LITHOLOGIC BOUNDARIES / PERMEABILITY / POROSITY DISTRIBUTIONS*
- *TOPOGRAPHY: FLOW SYSTEM GEOMETRY; HYDRAULIC GRADIENTS*
- *HYDROLOGIC BALANCE: POTENTIAL RECHARGE/DISCHARGE*

DESCRIBE THE GROUNDWATER REGIME :

- *STORAGE DISTRIBUTION: EFFECTIVE POROSITIES*
- *HYDRAULIC HEAD DISTRIBUTION: FLOW PATTERNS*
- *RECHARGE/DISCHARGE/FLUX: SEEPAGE VELOCITIES*
- *PHYSICAL/CHEMICAL PROPERTIES: DENSITY, VISCOSITY, TEMPERATURE*



A faint, grayscale world map serves as the background for the title page. The map is centered on the Atlantic Ocean, showing the continents of North America, South America, Europe, and Africa. Two small, dark circular markers are visible on the map: one in the North Atlantic and another in the Indian Ocean.

HYDROGEOLOGIC MODELLING CONCEPTS



HYDROGEOLOGIC MAPPING (regional scale)

PLOT (from existing maps / aerial photographs / data):

SURFACE DRAINAGE: rivers; lakes; tributary streams; catchment boundaries

*LITHOLOGY / STRUCTURE: geologic & geophysical signatures:
lineaments (major faults); bedrock and lithologic boundaries*

GROUNDWATER DISCHARGE PATTERNS: geologic controls; recharge and discharge area locations and area totals

AQUIFER CHARACTERISTICS: location; geometry; parameters

STREAM DISCHARGE STATION: location; catchment area; mean annual (m.a.) flow; m.a. base flow

WEATHER STATION: location; m.a. temperature, precipitation, rainfall, wind speed, direction

*CALCULATE: m.a. catchment yield (RY); m.a. base flow yield (BFY);
m.a. potential evaporation (PE); m.a. groundwater discharge use (GWDU); m.a. groundwater flux index (GWFI): assume $GWFI = BFY + PE$ (from GW discharge areas) + GWDU*



CANDIDATE AREA SELECTION

FAVOURABLE CHARACTERISTICS:

- regional upland location and low local topographic relief;
- few and widely spaced major lineaments (with few inter-spaced open fractures);
- absence of post-glacial faults and far from regional-scale faults;
- far from operating or abandoned mines and from known or inferred mineral deposition of future economic potential;
- in a region with a large areal extent and depth of plutonic rock, with uniform hydraulic properties, and extensive outcrop;
- absence of areas protected by legislation or publically valued;
- in a regional catchment with a LGWFI;
- contains areas of potential Candidate Site size (25 km²) with no evident large faults

CARRY OUT FIELD RECONNAISSANCE (geology, geophysics, hydrogeology)

EVALUATE FIELD DATA / SELECT 2 OR 3 CANDIDATE AREAS



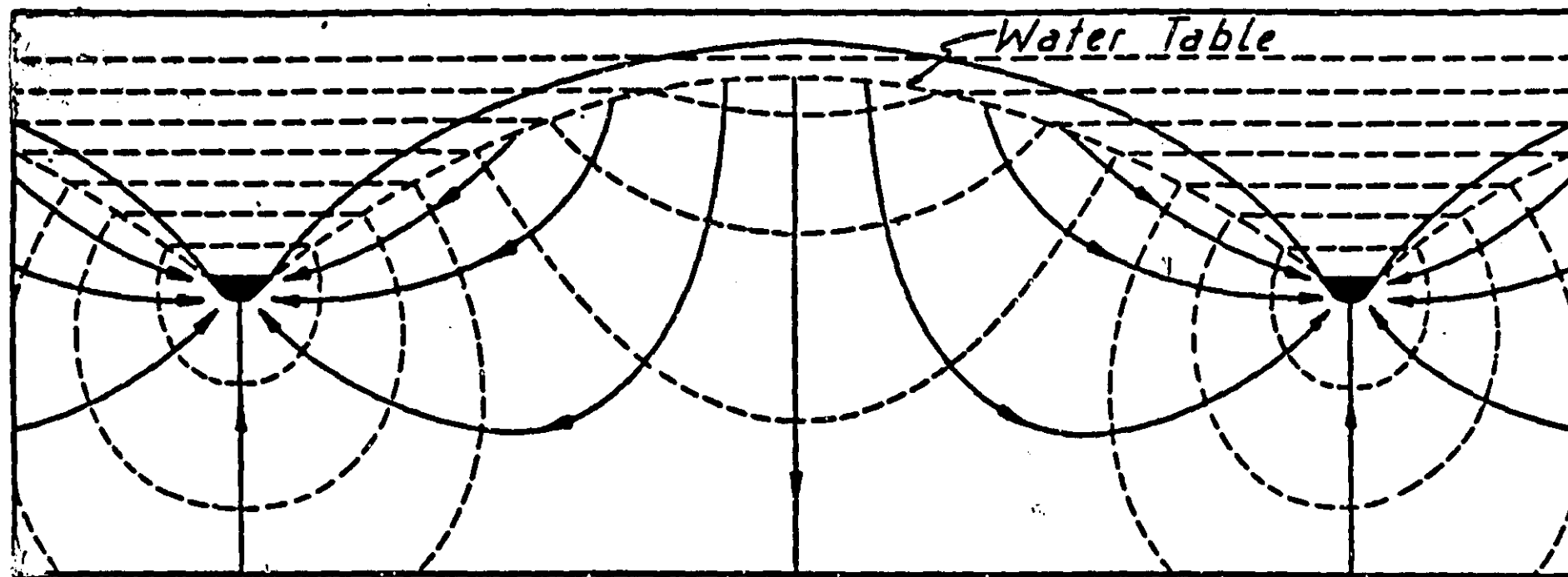


FIG. 45.—Approximate flow pattern in uniformly permeable material between the charges distributed over the air-water interface and the valley sinks.

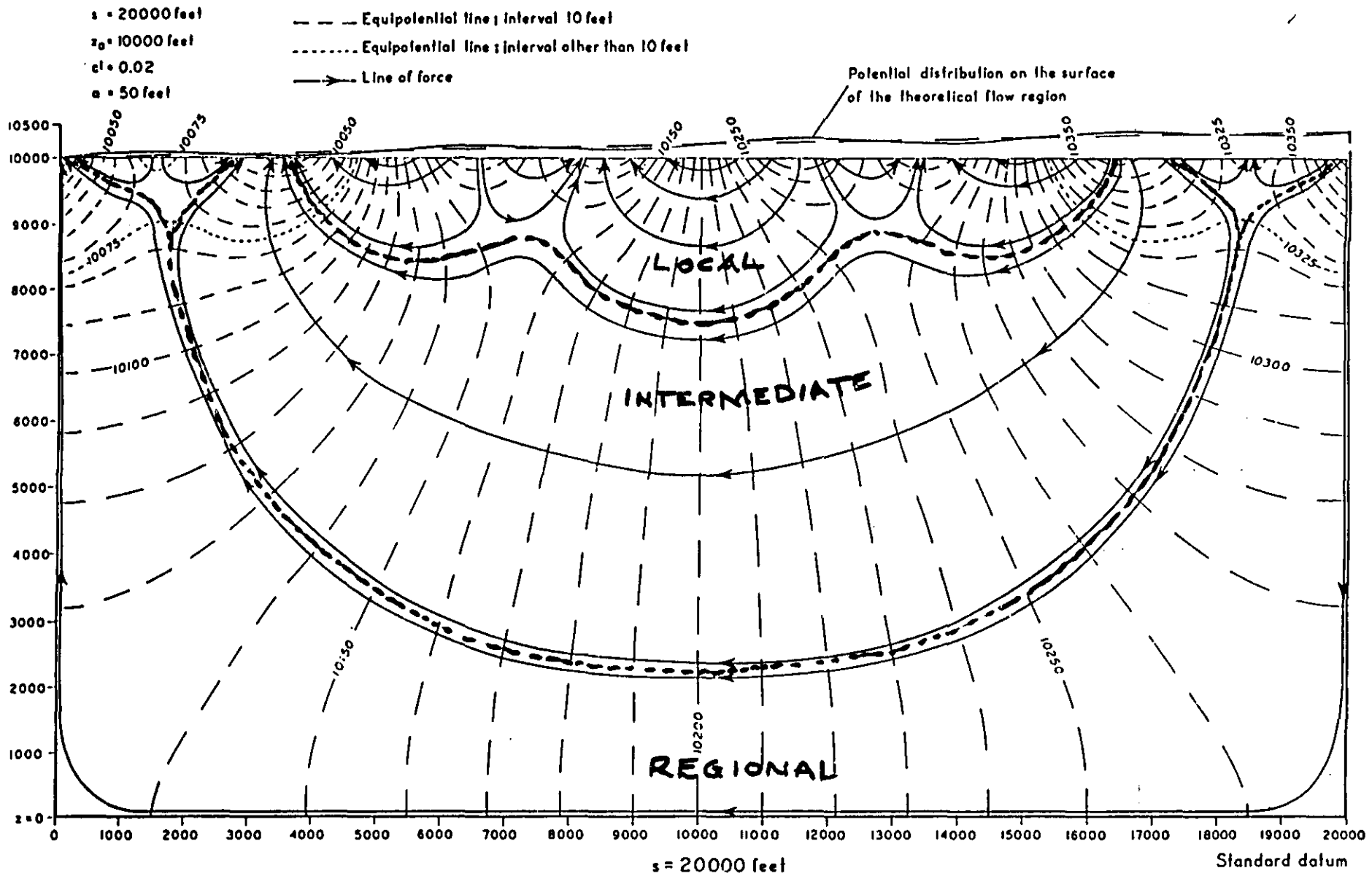


Fig. 2/. Potential distribution and flow pattern as obtained by equation 6.

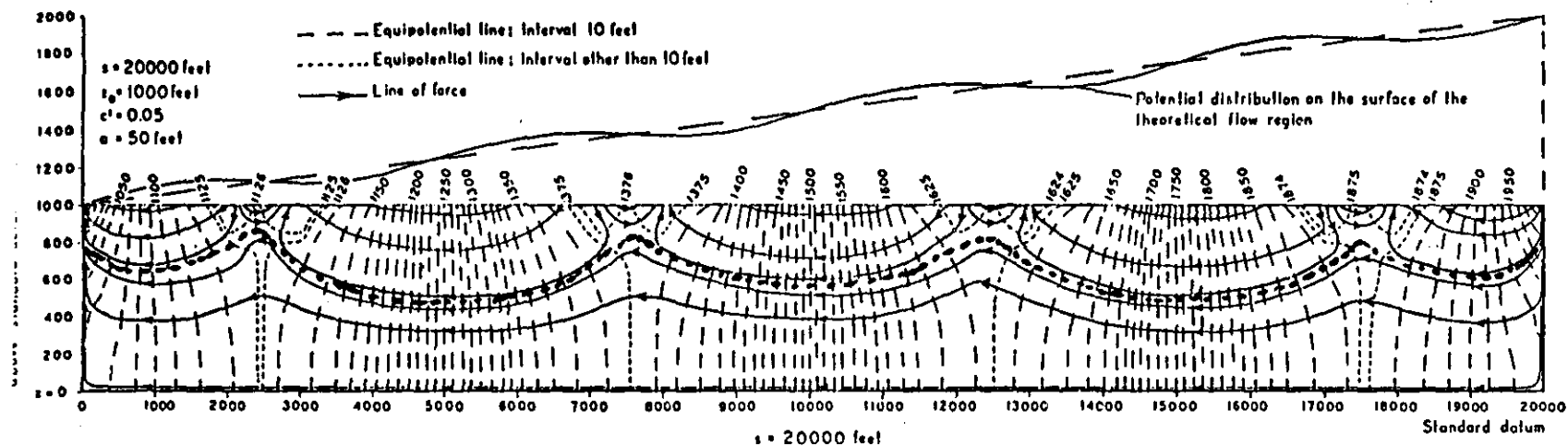


Fig. 2c. Potential distribution and flow pattern as obtained by equation 6.

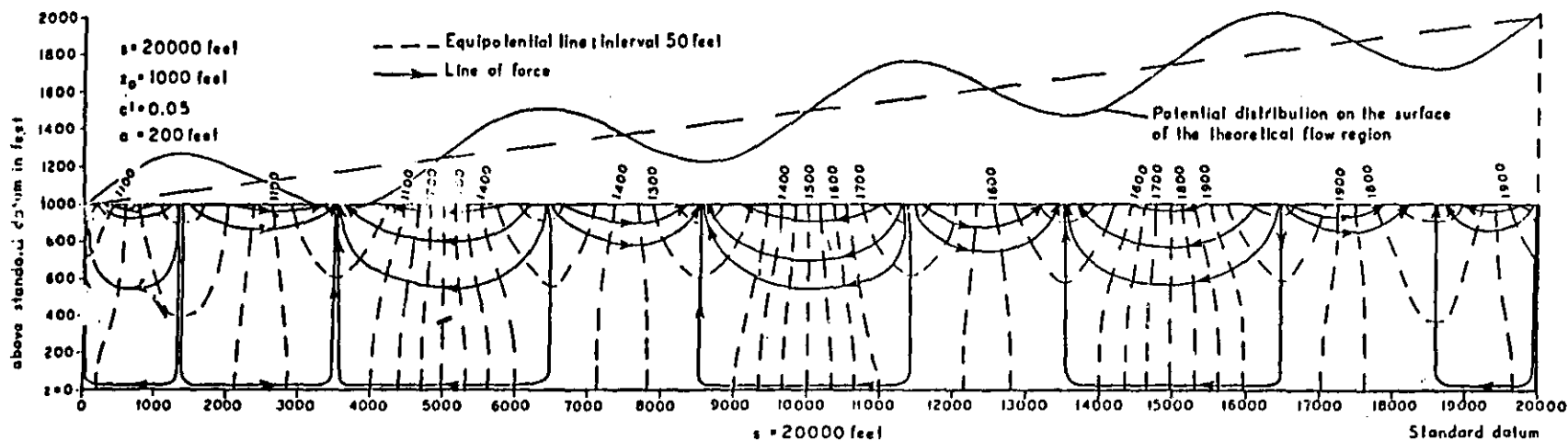


Fig. 2d. Potential distribution and flow pattern as obtained by equation 6.

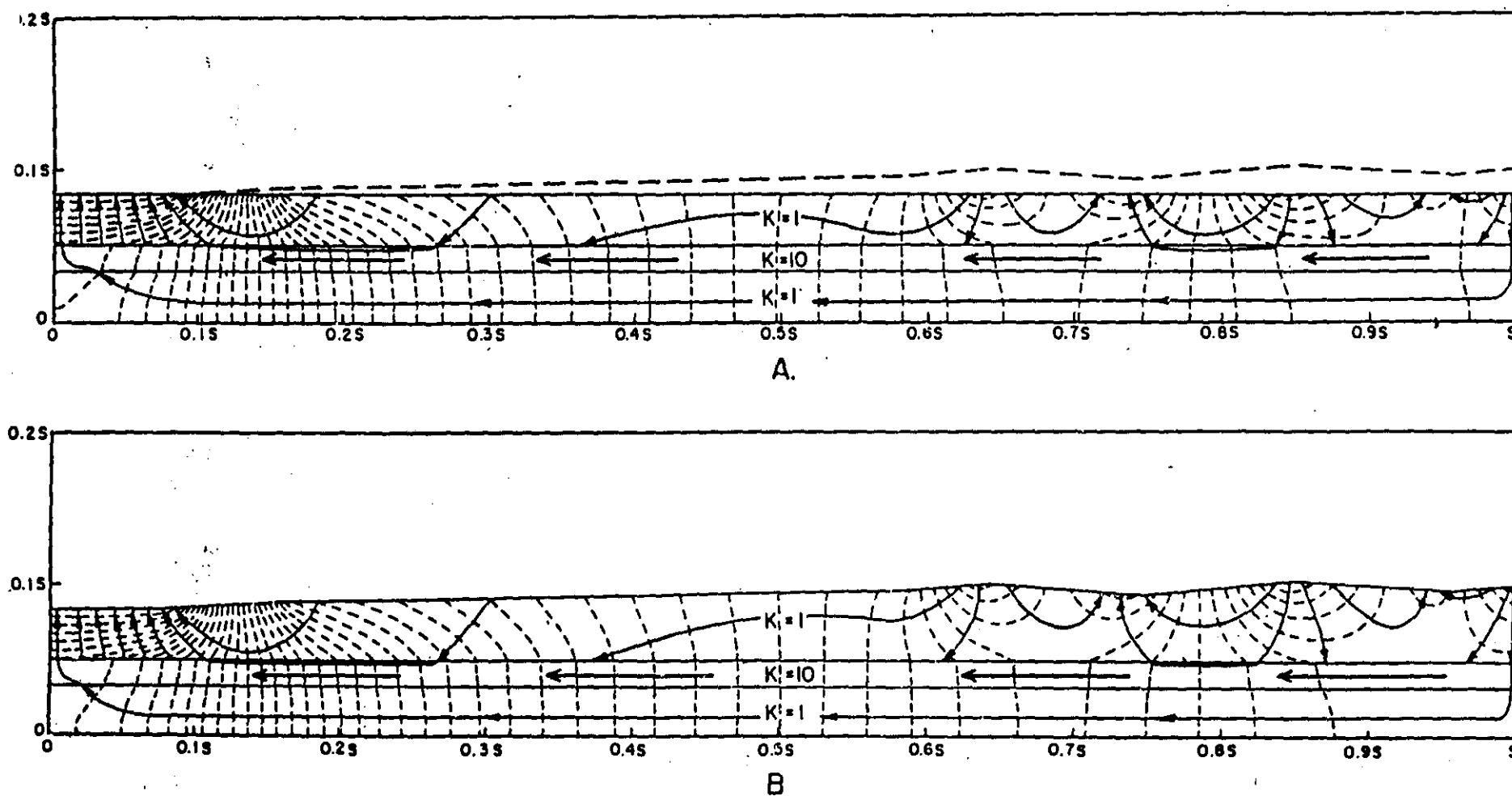


Fig. 7. Comparison of analytical solution (A) and numerical solution (B) to a hypothetical groundwater problem.

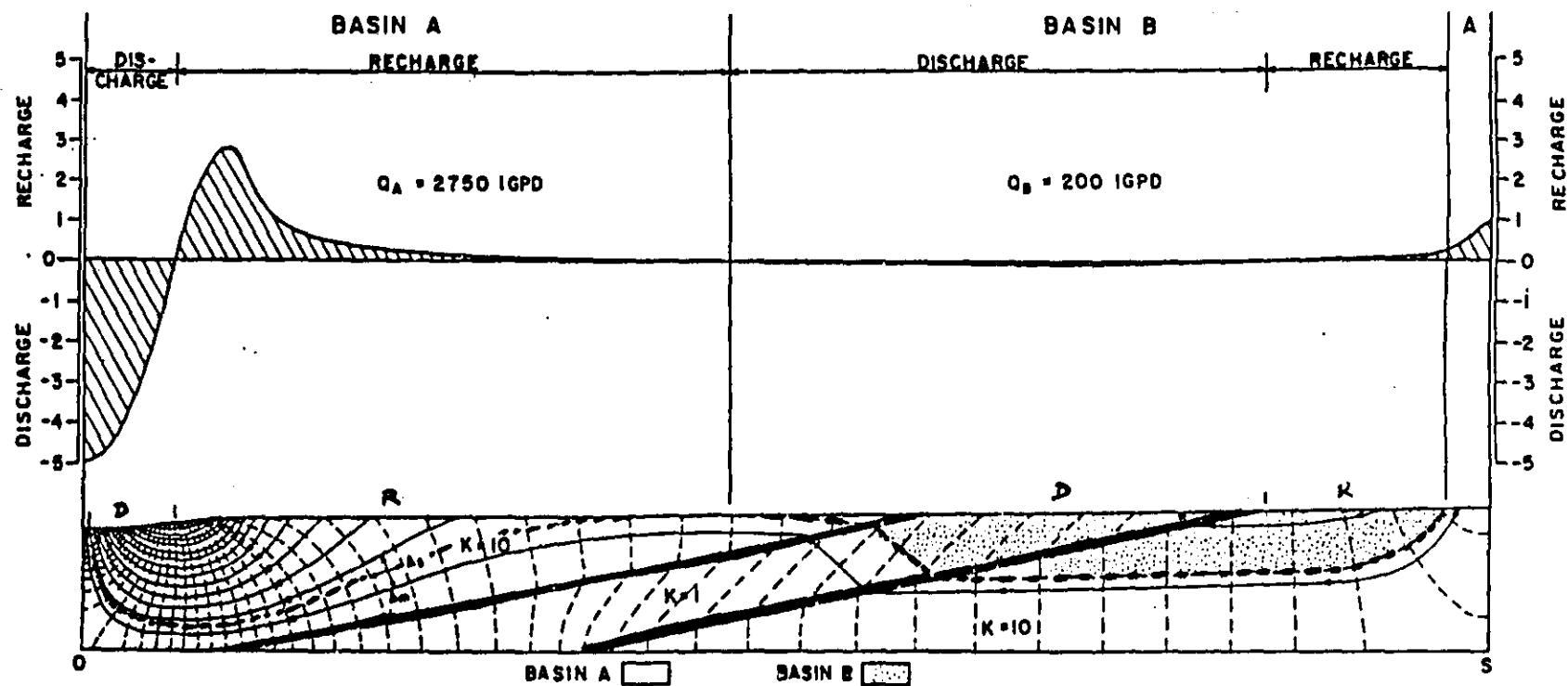


Fig. 1. Quantitative flow net and recharge-discharge profile for a two-dimensional, nonhomogeneous, isotropic composite ground water basin.

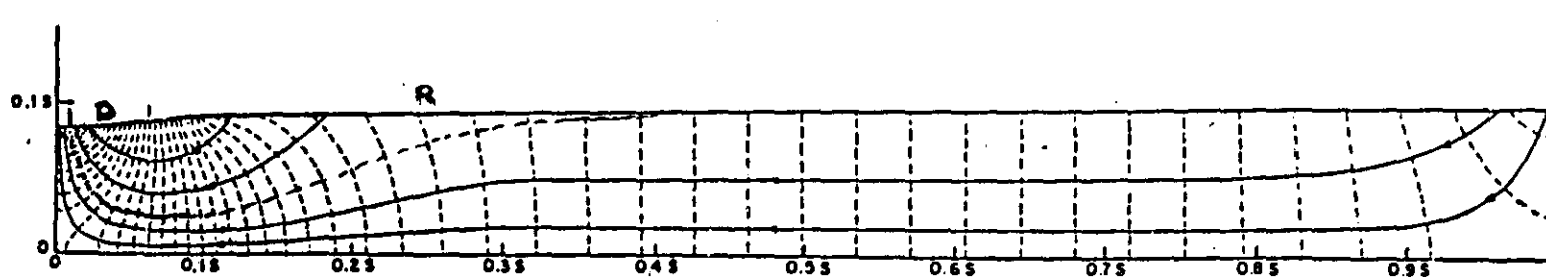
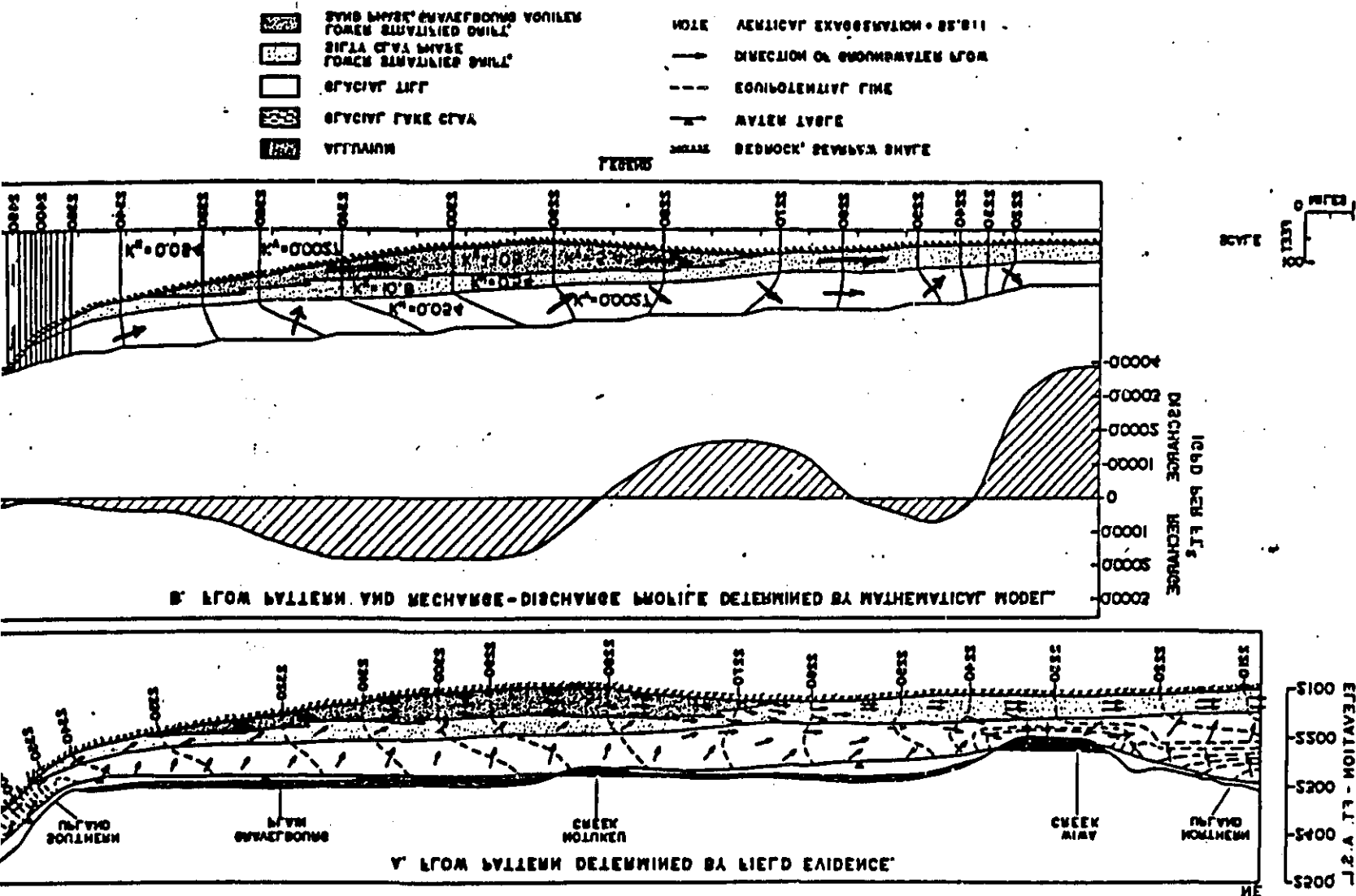


Fig. 3 Comparison of two-dimensional flow patterns for chloride and zinc chloride



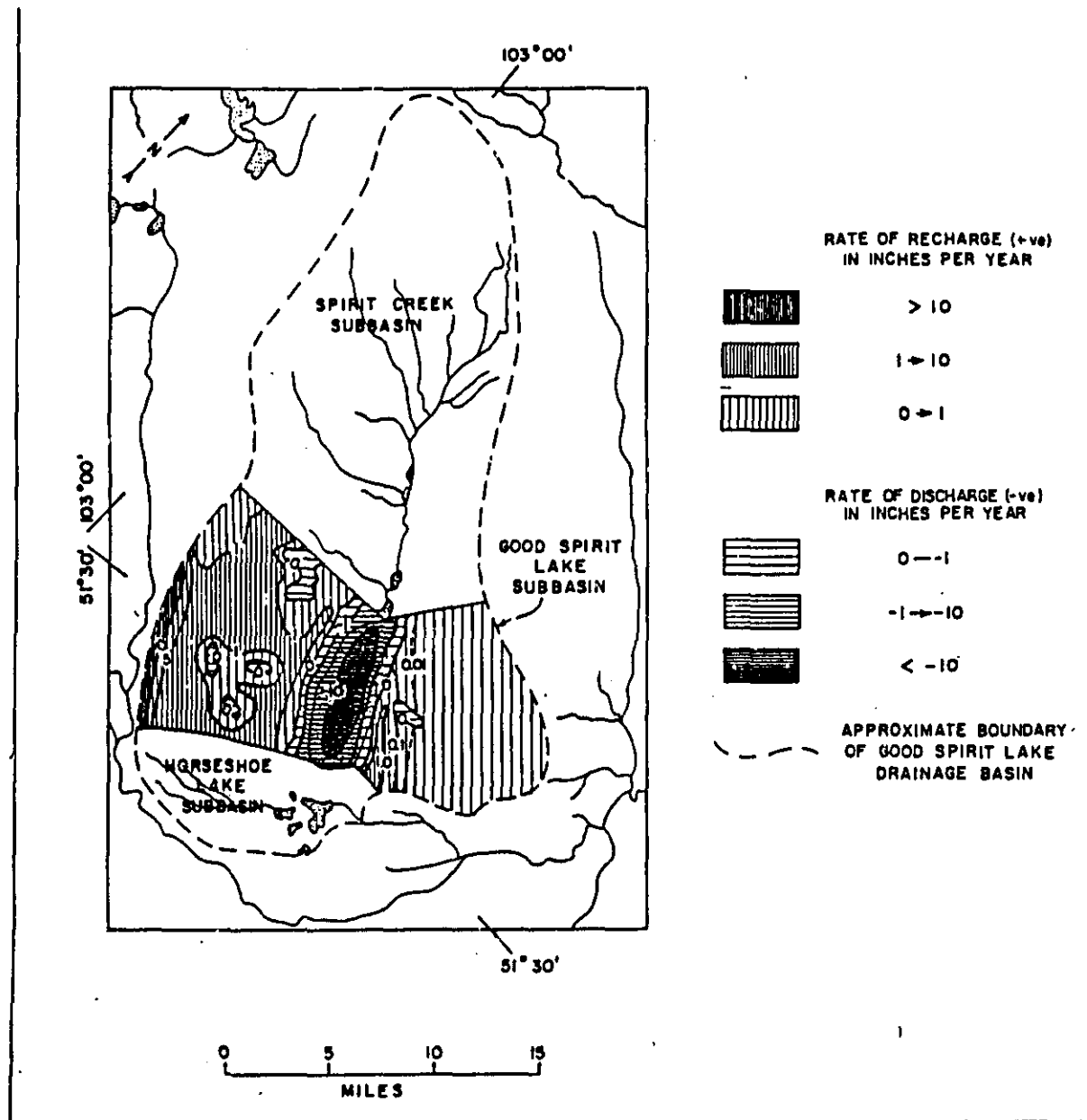


Fig. 3. A recharge-discharge map from a three-dimensional field example, Good Spirit Lake drainage basin, Saskatchewan, Canada (after Freeze, 1967c).

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CANDIDATE AREA CHARACTERIZATION :

- *OPTIMIZING SITE CHARACTERIZATION COSTS*
- *REMOTE SENSING, AIRBORNE SURVEYS, AND RECONNAISSANCE MAPPING*
- *BOREHOLE SITING, DRILLING AND LOGGING, AND TESTING*
- *PIEZOMETER CONSTRUCTION AND MONITORING*
- *GROUNDWATER SAMPLING*
- *DATA COLLECTION, ANALYSIS AND ARCHIVING*
- *CONCEPTUAL HYDROGEOLOGIC MODEL CONSTRUCTION*



OPTIMIZING SITE CHARACTERIZING COSTS

STRATEGY: *use the conceptual hydrogeologic modelling group*

- *(which includes a senior member of each scientific discipline involved in the siting process) to identify and specify the required complementary characterization data needed to design and validate or adjust the conceptual hydrogeologic models of the Candidate Areas.*

PROCEDURE: *form a conceptual hydrogeologic modelling group; study the hydrogeologic map and preliminary conceptual model of each Candidate Area; identify the complementary data needed by each scientific discipline (geology, geophysics, geochemistry, hydrogeology) to complete a conceptual hydrogeologic model; locate the grid areas and boreholes at which the required data could be collected in the most efficient way*



CANDIDATE AREA CHARACTERIZATION :

- *OPTIMIZING SITE CHARACTERIZATION COSTS*
- *REMOTE SENSING, AIRBORNE SURVEYS, AND RECONNAISSANCE MAPPING*
- *BOREHOLE SITING, DRILLING AND LOGGING, AND TESTING*
- *PIEZOMETER CONSTRUCTION AND MONITORING*
- *GROUNDWATER SAMPLING*
- *DATA COLLECTION, ANALYSIS AND ARCHIVING*
- *CONCEPTUAL HYDROGEOLOGIC MODEL CONSTRUCTION*



REMOTE SENSING, AIRBORNE SURVEYS AND RECONNAISSANCE MAPPING

CONSTRUCT MAPS OF PLUTON LITHOLOGY AND STRUCTURE:

show surficial materials, lithologic boundaries, pluton geometry, lineaments or major faults (using geologic & geophysical signatures):

MAP HYDROGEOLOGIC CONDITIONS:

geographic features; surface drainage; groundwater discharge patterns and areas; groundwater discharge features (springs; seepage); water well locations/characteristics (yield & quality); aquifer characteristics (location, geometry & parameters)

CONSTRUCT 2-D SECTIONS: *showing plotted features given above, and conceptual groundwater flow systems compatible with mapped features*



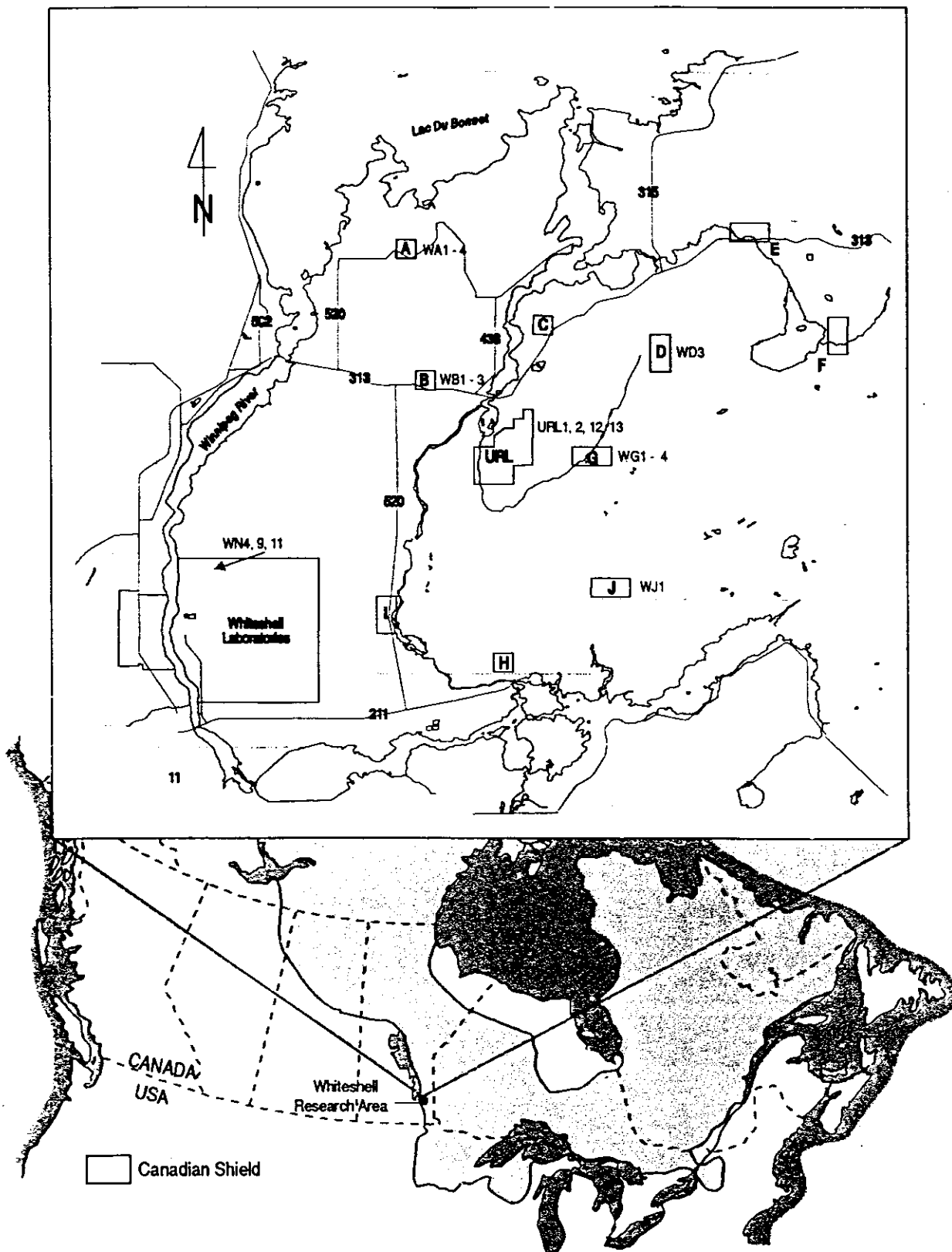


FIGURE 1: Locations of the Canadian Shield, Whiteshell Research Area (WRA), Grid areas, the URL and Whiteshell Laboratory sites, and identifications of deep boreholes (over 500 m length) drilled at the WRA

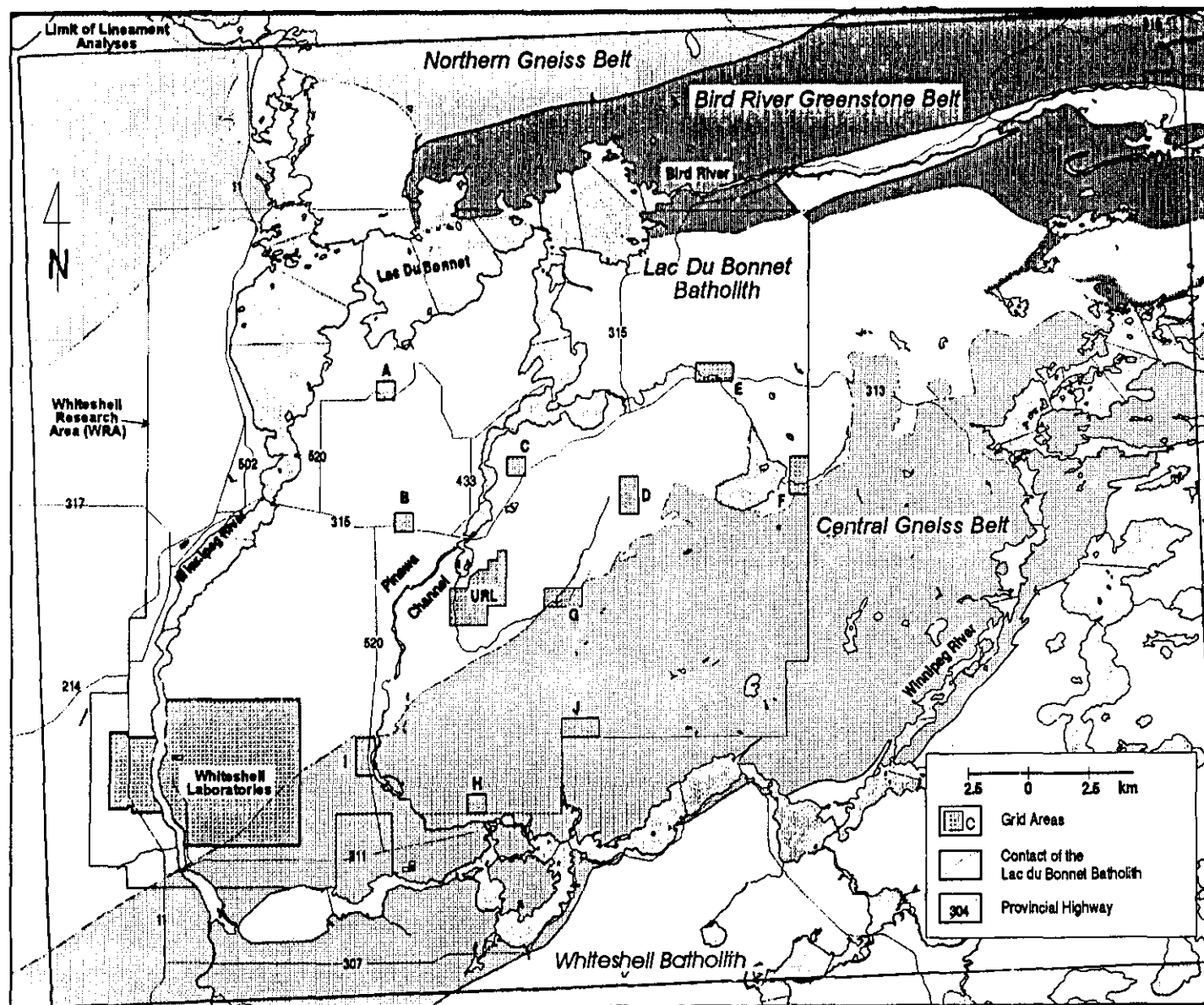
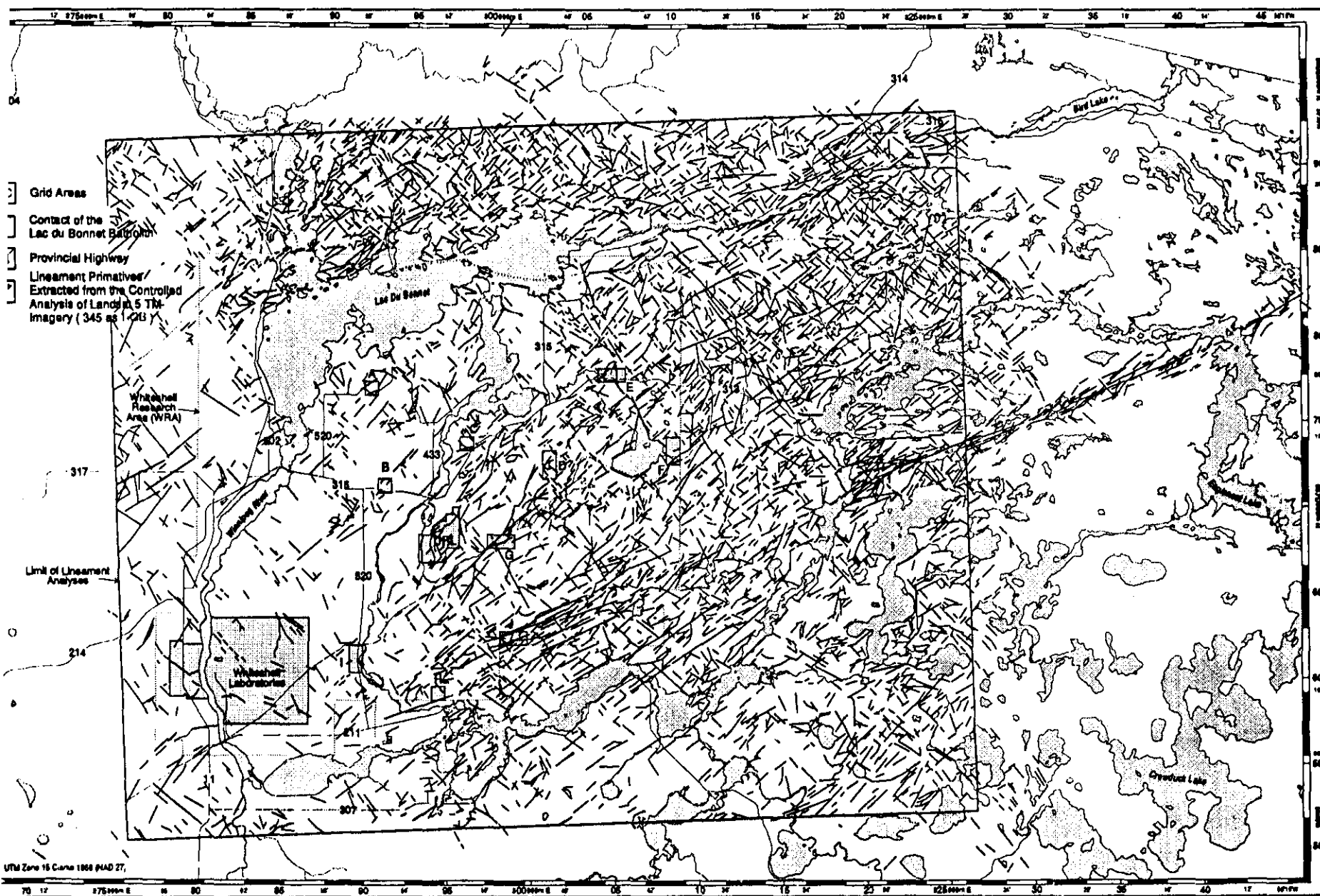
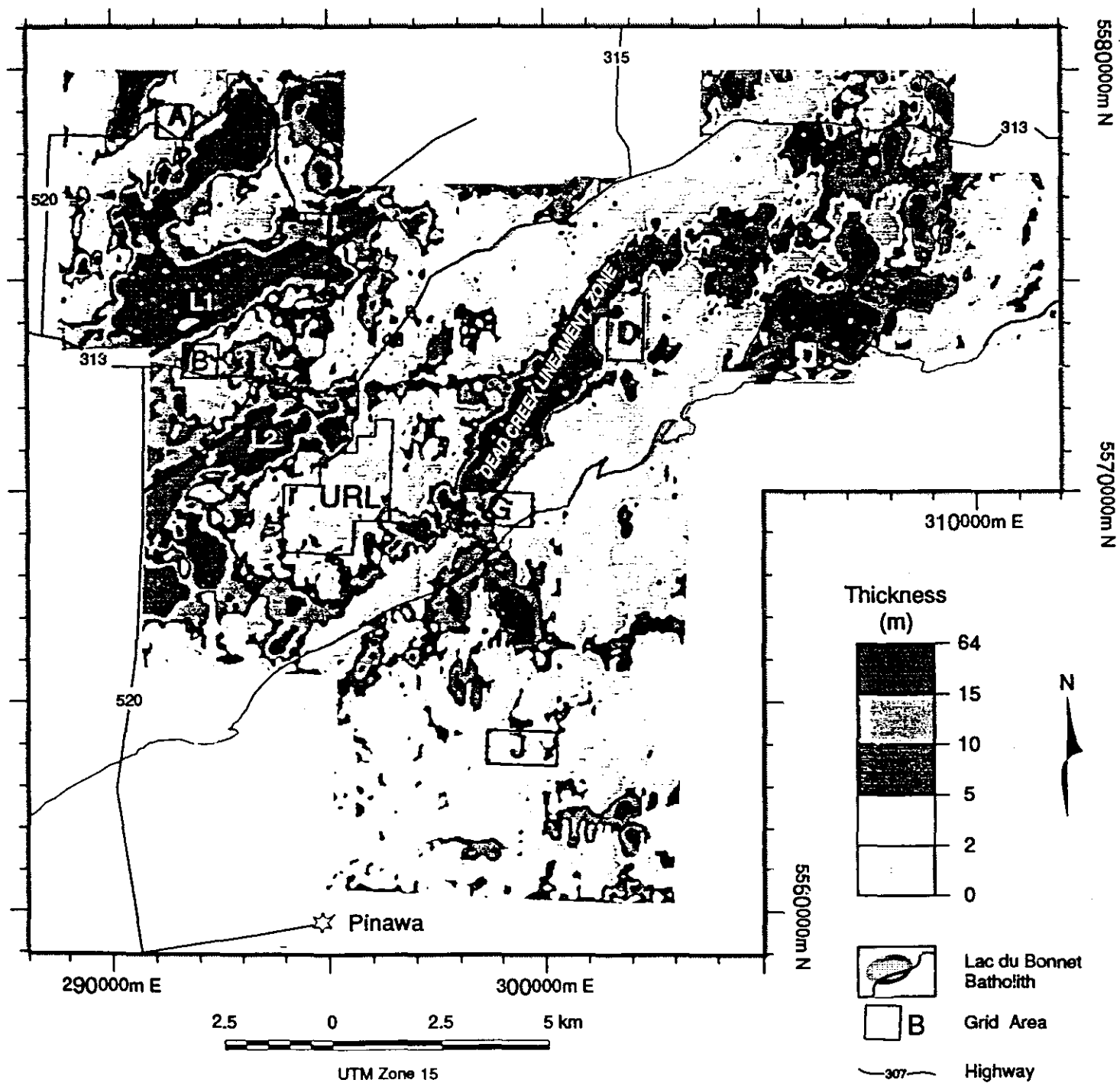
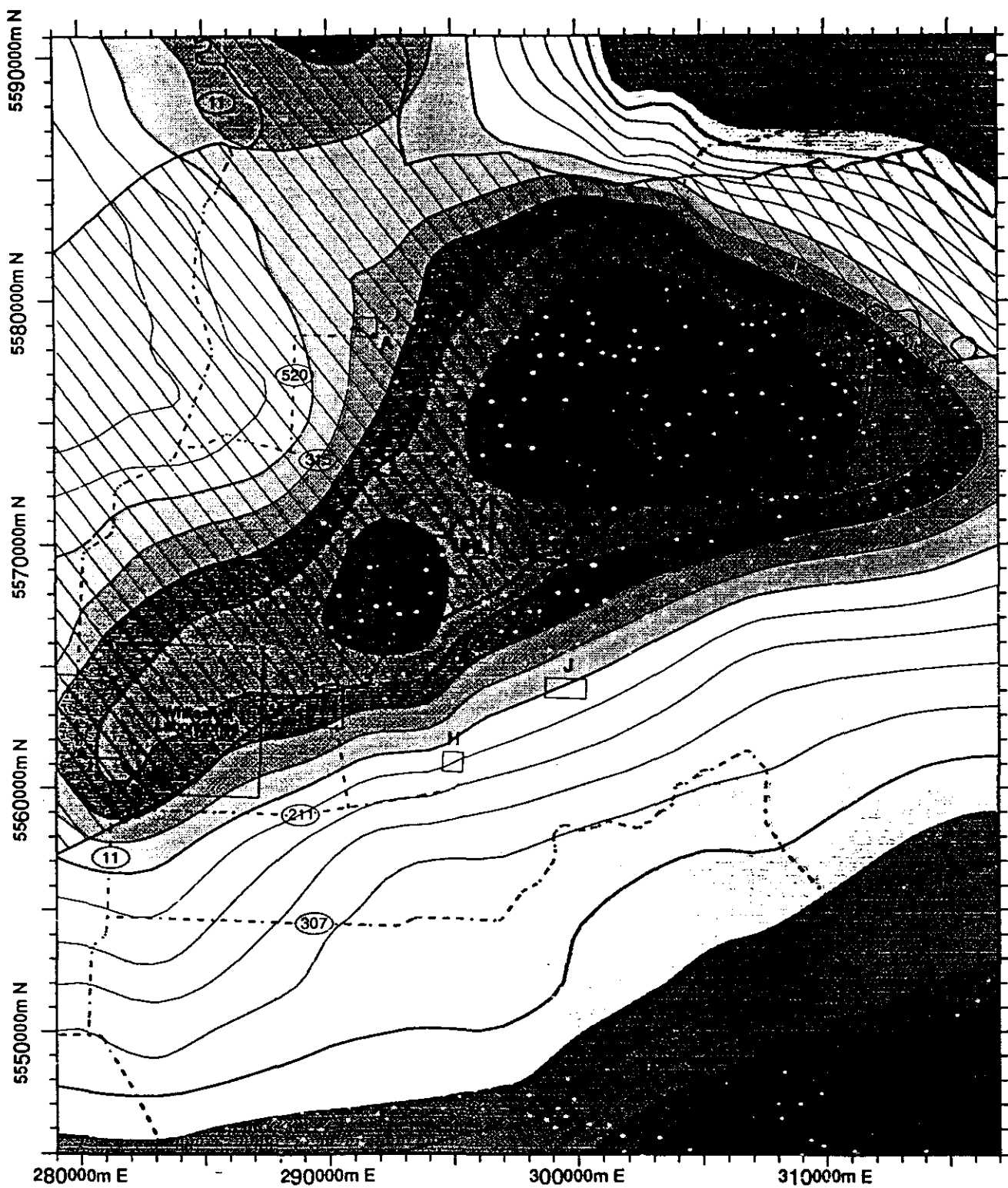
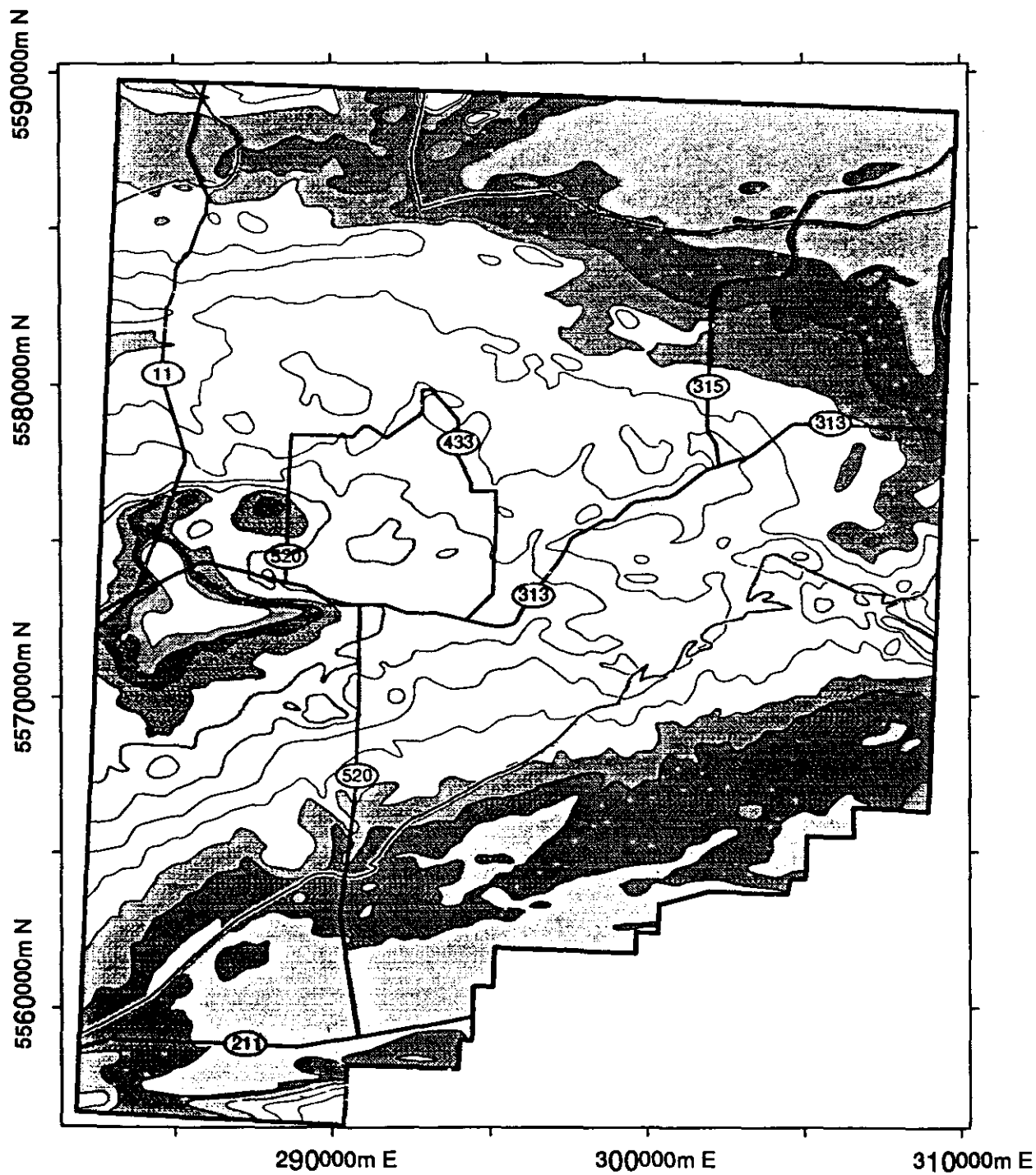


Figure 2: Lithologic boundaries in the map area around Whiteshell Research Area

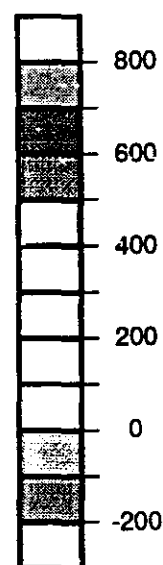








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UTM Zone 15

○ Lac du Bonnet Batholith
 —(211)— Highway

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 km

