



CanGEA

Canadian Geothermal

Energy Association

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Understanding Geothermal

- ▶ Crucial variables to successful development
 - ▶ Heat (resource)
 - ▶ Water (medium)
 - ▶ Flow/Permeability
- ▶ Need to understand all variables; lots of research for Canadian resource
- ▶ Recent developments: Enhanced Geothermal Systems or EGS



Geothermal Energy!



- ▶ Renewable, reliable source of electricity and heat
- ▶ Geothermal power sources produce long term revenues with no fuel costs and near zero emissions.
- ▶ Small environmental footprint compared to other power sources
- ▶ Geothermal power plants can continuously deliver power with >95% capacity
- ▶ Preferred choice of renewable energy for many utilities
- ▶ **HIGH RISK** to develop Resource!

From Earth's Heat Energy to Electricity Production

CURRENT STATE OF GEOTHERMAL INDUSTRY IN CANADA?

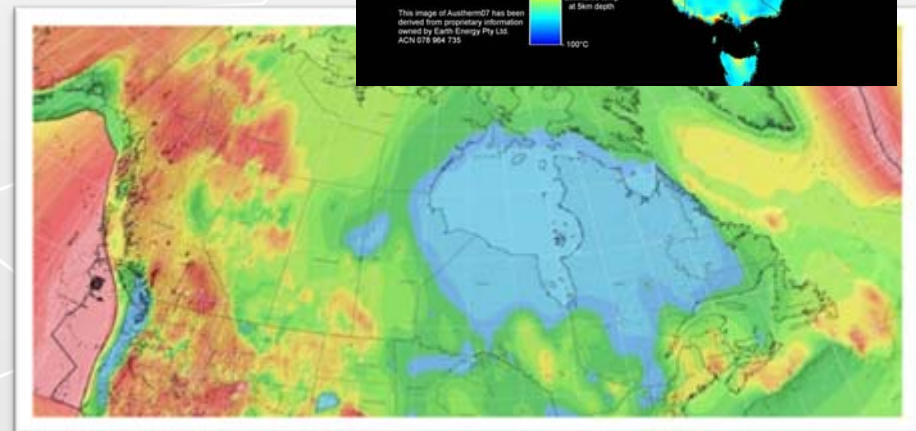
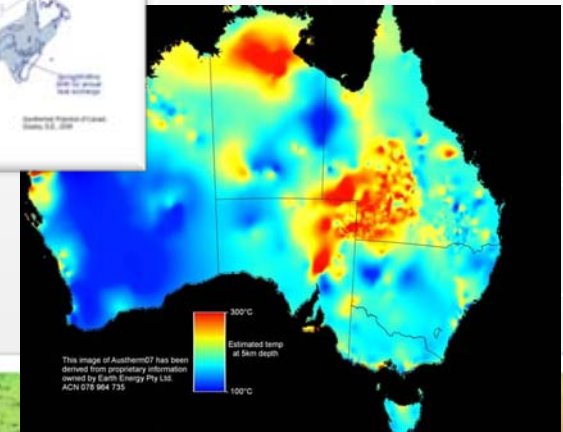
Canadians Everywhere



- ▶ Major resource trading partner; key supplier of energy to North America
- ▶ Canadian geothermal influence
 - Companies (TSX-V: SGP, Western Geopower, Polaris, NGP...)
 - Scientists and researchers
 - Investment Community (Jacob & Company, Dundee)
- ▶ Working for geothermal worldwide, need to bring the knowledge resource home

Canadian Energy Potential?

- ▶ 0 MW: Industry needs jumpstart
- ▶ Numerous estimates of MW potential
- ▶ Need unbiased heat resource number from respected third party (GSC, BC EMPR...)
- ▶ 1 MW would supply 800 Canadian homes



Electricity/Project Potential



Electrical energy from geothermal resources is officially classified by Natural Resources Canada as a 'renewable' energy, meaning that they operate without destroying finite natural resources.

- ▶ Meager Creek-300MW?
- ▶ Pebble Creek-Mt. Cayley
- ▶ Canoe HotSprings
- ▶ Harrison Hot springs
- ▶ Mining Opportunities
- ▶ Oil & Gas Applications
- ▶ General estimates not helpful for individual project financing

From Earth's Heat Energy to Electricity Production

BRINGING GEOTHERMAL TO CANADA

Building Critical Mass



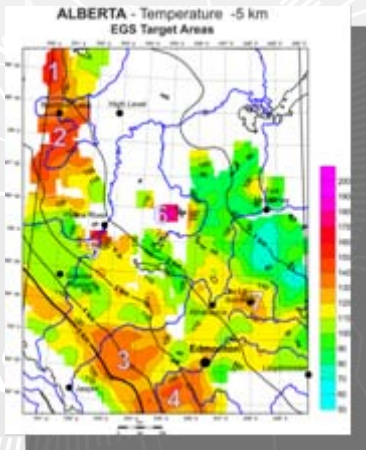
- ▶ Re-vitalization of CanGEA: Major corporate industry involvement including geothermal, oil & gas companies and renewed interest in renewable energy
- ▶ A coming together of industry, academia, government and grassroots program: Individuals and volunteers
- ▶ **Need SIGNIFICANT assistance to move industry forward in Canadian market**



Starts with Research



- ▶ University of British Columbia:
 - Yellowknife & Sudbury (abandoned mines)
 - 4 MWt greenhouse project
 - BC EMPR Waste water potential
 - EGS Research
- ▶ Queen's co-production research (oil & gas field thermal waters)
- ▶ Database accumulation (BC Hydro, BC EMPR, CanGEA, GSC)
- ▶ GSC data review: Dr. Jessop
- ▶ EGS Study for Alberta: Dr. Moore, Dr. Majorwicz with Alberta Energy Research Institute
- ▶ Company exploration programs in BC, Alberta and Yukon
- ▶ International Policy Review – CanGEA/WellDunn





Follow Worldwide Lead

- ▶ >3,000 MW in US Market
- ▶ Iceland, Italy
- ▶ Leaders-
Australia,
Germany,
New Zealand
- ▶ Proven
Technology



Opportunity to learn from other countries and their successful geothermal policies

Industry development: Example -Australia



39 companies have applied for 347 licences covering
>257,000 km² in Australia

10 ASX-listed Hot Rock Companies

Work programs (2002-13) worth A\$996 million

Australian Governments have committed > \$100 million for research and demonstration since 2000

Geothermal Industry Development Framework and
Technology Roadmap in progress

Cost Benefit Analysis – 1:15 Every dollar that
government puts in earns royalties and taxes of \$15 over
10 years

From Earth's Heat Energy to Electricity Production

WHAT DOES INDUSTRY NEED?

Program for Success



- ▶ *Reduce RISK: Financial/Drilling/Project*
- ▶ Central database of existing data
 - Mining & Oil and Gas
 - BC EMPR, BC Hydro, GSC....
 - Private information
 - University research
- ▶ GIS based mapping programs
- ▶ Field research (mapping, sampling)
- ▶ Geophysics
- ▶ Continue developing drilling/subsurface dataset
- ▶ Training/education for next generation

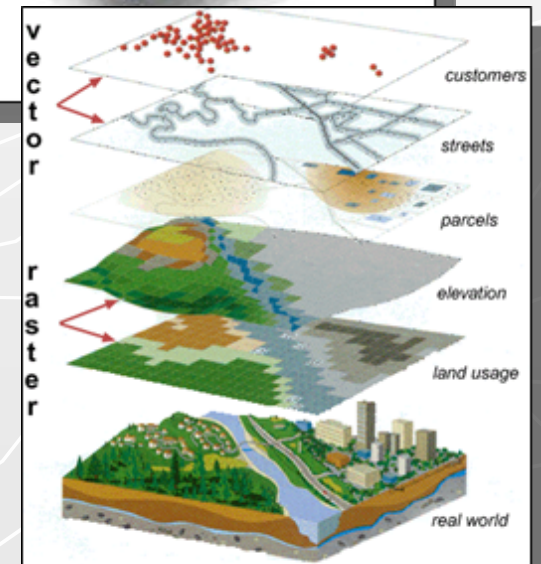
Facilitate Exploration Research



- ▶ Starts at a desk (with a phone & computer)
- ▶ Need to locate as much data as possible prior to any serious consideration
- ▶ BC Hydro reports, satellite imagery, GSC mining information, field mapping etc.
- ▶ Start to put a picture together
- ▶ Canadian dataset not centralized
- ▶ Digital database would facilitate research and lower costs: **REDUCING RISK**

GIS Mapping

- ▶ New age in mapping technology
- ▶ Geographic Information System (GIS)
- ▶ Layer system (BC EMPR: mining, oil & gas)
- ▶ Import datasets (ARC or shp files)
 - Well data (temp grad, locations)
 - Geology (faults, lithology)
 - Infrastructure (transmission, roads, towns...)
- ▶ Allows exploration geologists to see the patterns



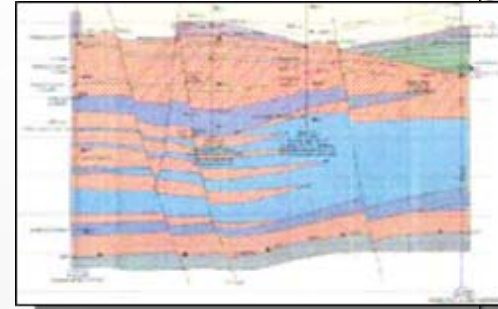
Necessary Field Research

- ▶ Temperature gradient data
- ▶ Exploration for hot water/hot springs
- ▶ Water chemistry & geothermometry
- ▶ Surface geochemistry
- ▶ Geological mapping (lithology, alteration & structural)
- ▶ Fundamental in bringing necessary information to industry
- ▶ 1980's GSC geothermal funding terminated: BRING IT BACK



Geophysics Program

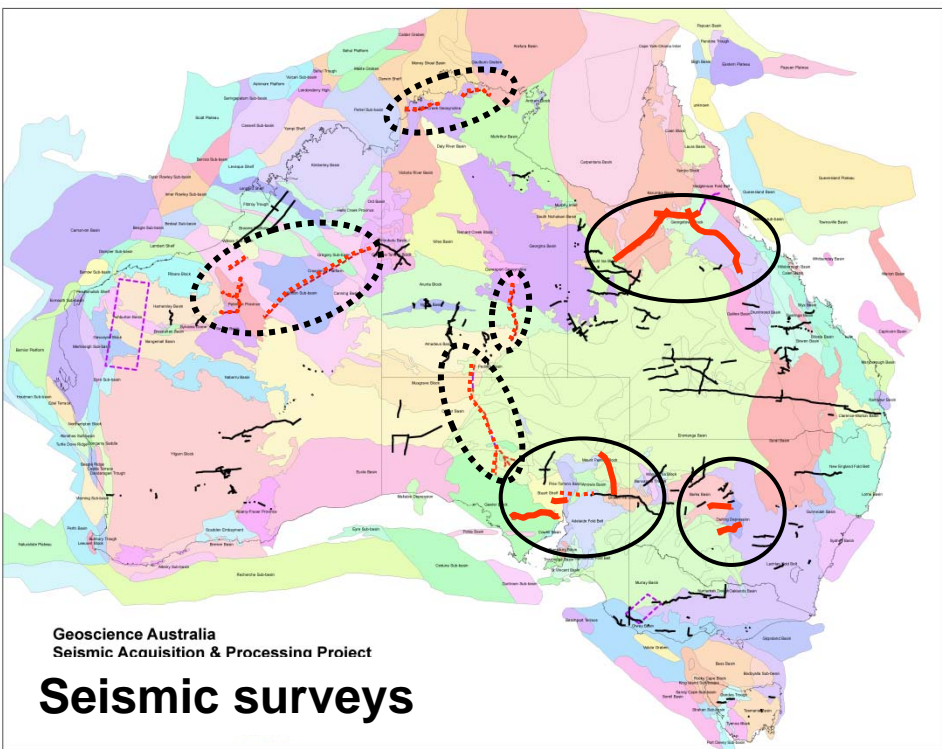
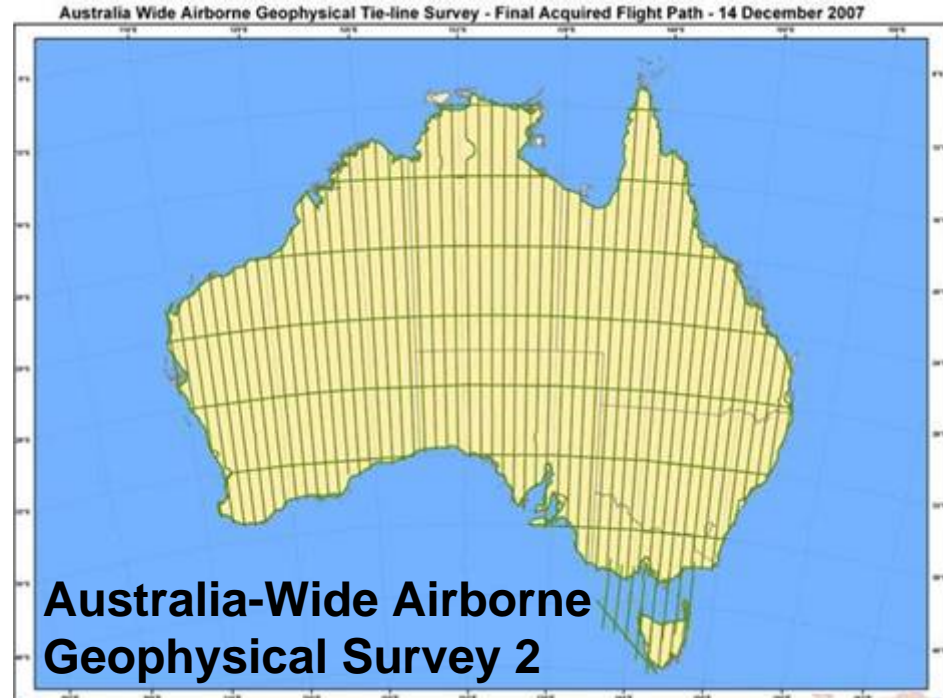
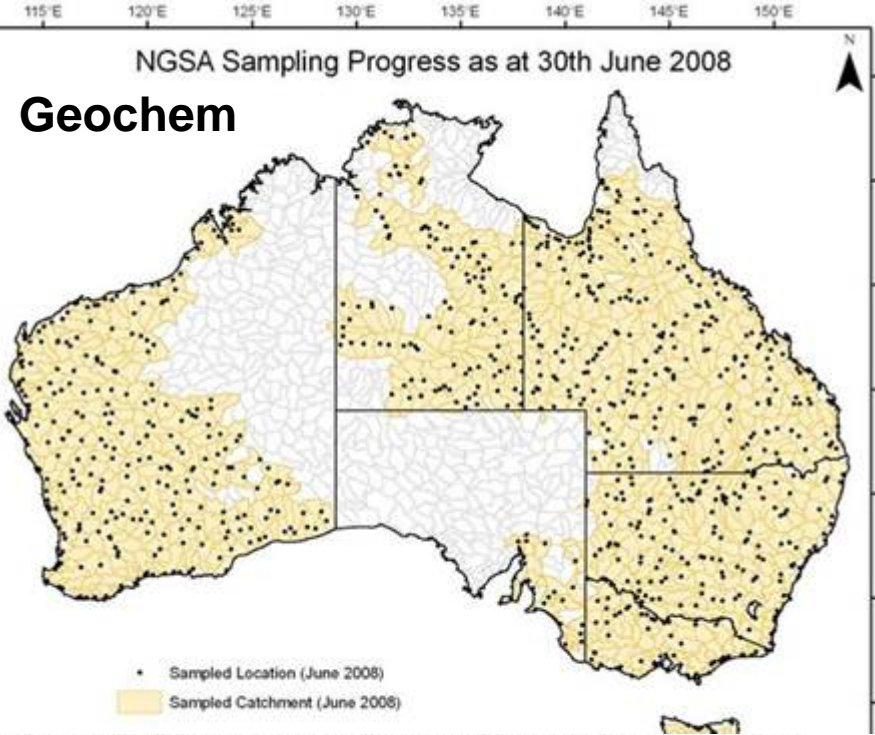
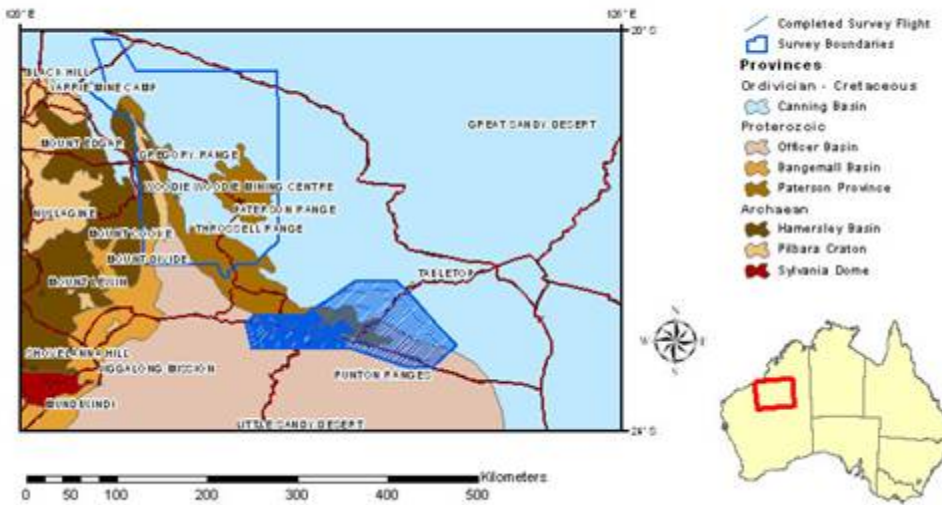
- ▶ Techniques can help us determine
 - Reservoir structure
 - Change in lithology @ depth
 - Heat flow potential & anomalies
 - Valuable tool to look into the subsurface without the drilling




- ▶ Active & Passive Seismic
- ▶ Infrared
- ▶ Gravity
- ▶ Aero & Surface Magnetics
- ▶ Resistivity
- ▶ Used in Oil & Gas and Mining exploration

Airborne Electromagnetics

AEM Survey Areas
Paterson Region, Western Au:



Drilling Support

- ▶ Drilling is reality: “Ground Truth” (proves or disproves all the theories)
 - ▶ Shallow temperature probes
 - ▶ Temperature gradient holes for reservoir delineation
 - ▶ Tells us about lithology, fault system/structural environment, heat resource, and drilling issues
 - ▶ Need to improve % of successful production wells
 - ▶ \$5million/well or drilling insurance
- 
- ▶ Very expensive, high risk portion of geothermal development: **NEED TO REDUCE THIS RISK**
 - ▶ Costs & success rate can make or break geothermal exploration companies: **MAKES INVESTORS WEARY**

Reduce Project Risk!

- ▶ Not just drilling!
- ▶ Electricity is “perishable good” : transmission can dictate economics
- ▶ Environmental Concerns
- ▶ Cultural Issues
- ▶ Political Atmosphere
- ▶ Power Pricing
- ▶ Need quality geoscience to improve odds for geothermal industry



Support: New Geoscientists



- ▶ “Help wanted” : Next generation of GeoScientists
- ▶ Need for qualified scientists & engineers in field of geothermal
- ▶ Few courses offered worldwide (Iceland, Stanford, New Zealand)
- ▶ High % of experienced researchers near retirement age
- ▶ Opportunity to pass on the knowledge to next generation
- ▶ Fresh perspective & new ideas

Just the start...

- ▶ Advanced exploration techniques of hydrothermal systems (isotope analysis)
- ▶ EGS fracturing research
- ▶ Microgeneration & <10MW drilling programs
- ▶ Pore space policy & co-production opportunities
- ▶ Granitic drill bit technology
- ▶ CO₂ heat medium
- ▶ Reservoir analysis in Canadian Cordilleran
- ▶ Increased technology transfer from other industries

General Education

- ▶ What's geothermal? Electricity?
- ▶ Amazing renewable energy resource, yet not widely recognized (including investment community)
- ▶ Resource potential only primary assessment
- ▶ Difficult to move forward with exploration and development
- ▶ Outreach & education for communities with geothermal energy opportunities
- ▶ Workshops & information available for decision makers



Helping Development

- ▶ Initial data collection and database
- ▶ Field research
- ▶ Geophysics
- ▶ GIS mapping
- ▶ Drilling program
- ▶ Researchers for tomorrow
- ▶ Education for public
- ▶ Continue to advance research



TAKEAWAY: Need to REDUCE RISK of project development to entice investment

High-Temperature Geothermal



- ▶ Base-load (>95% capacity factor)
- ▶ Domestic resource
- ▶ Mature and cost-competitive
- ▶ Produces near zero GHG emissions
- ▶ Small environmental footprint
- ▶ Sustainable resource, renewable energy
- ▶ Lowest long-term cost of all alternatives

QUESTIONS?

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