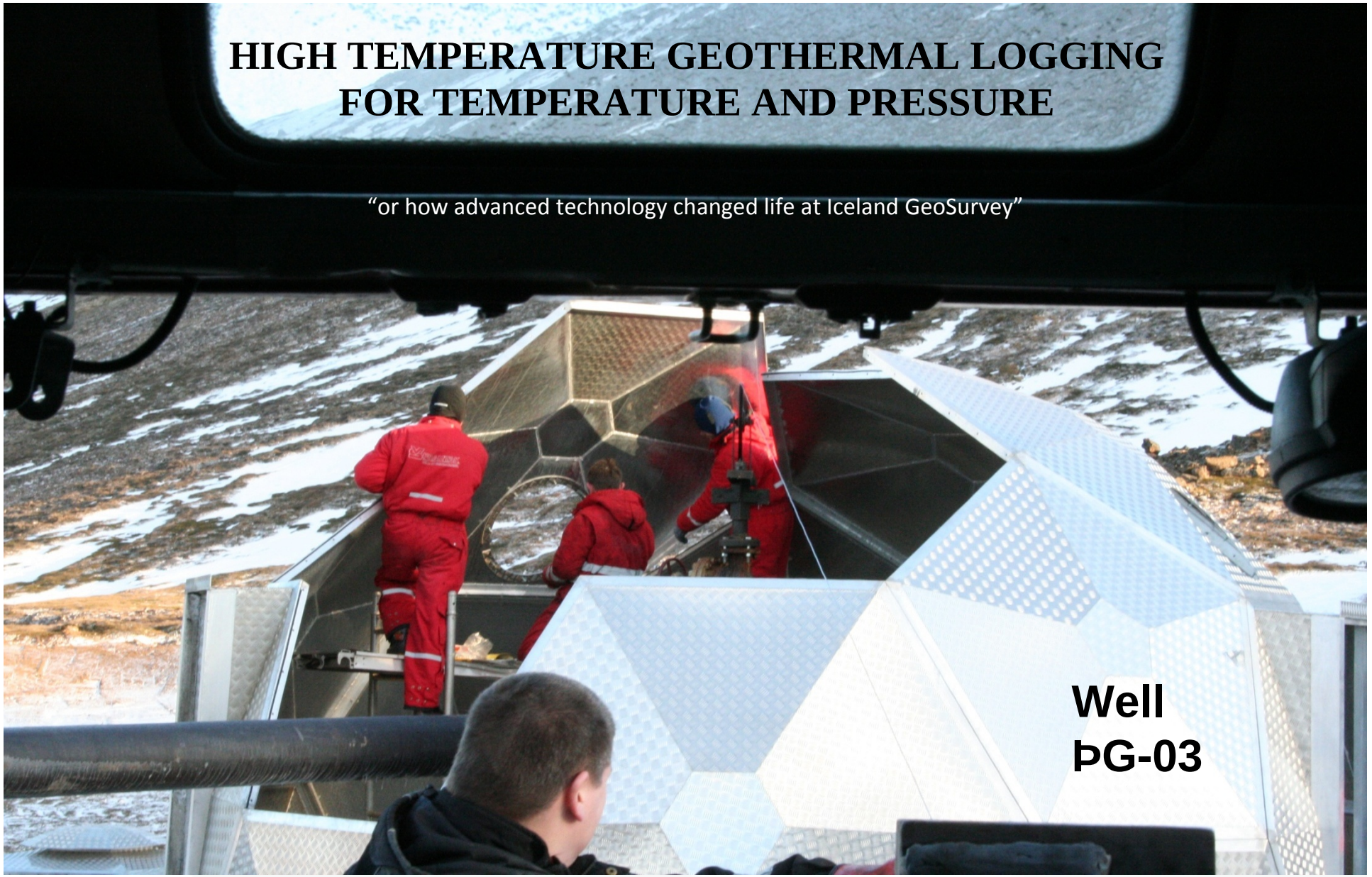
HIGH TEMPERATURE GEOTHERMAL LOGGING FOR TEMPERATURE AND PRESSURE

"or how advanced technology changed life at Iceland GeoSurvey"



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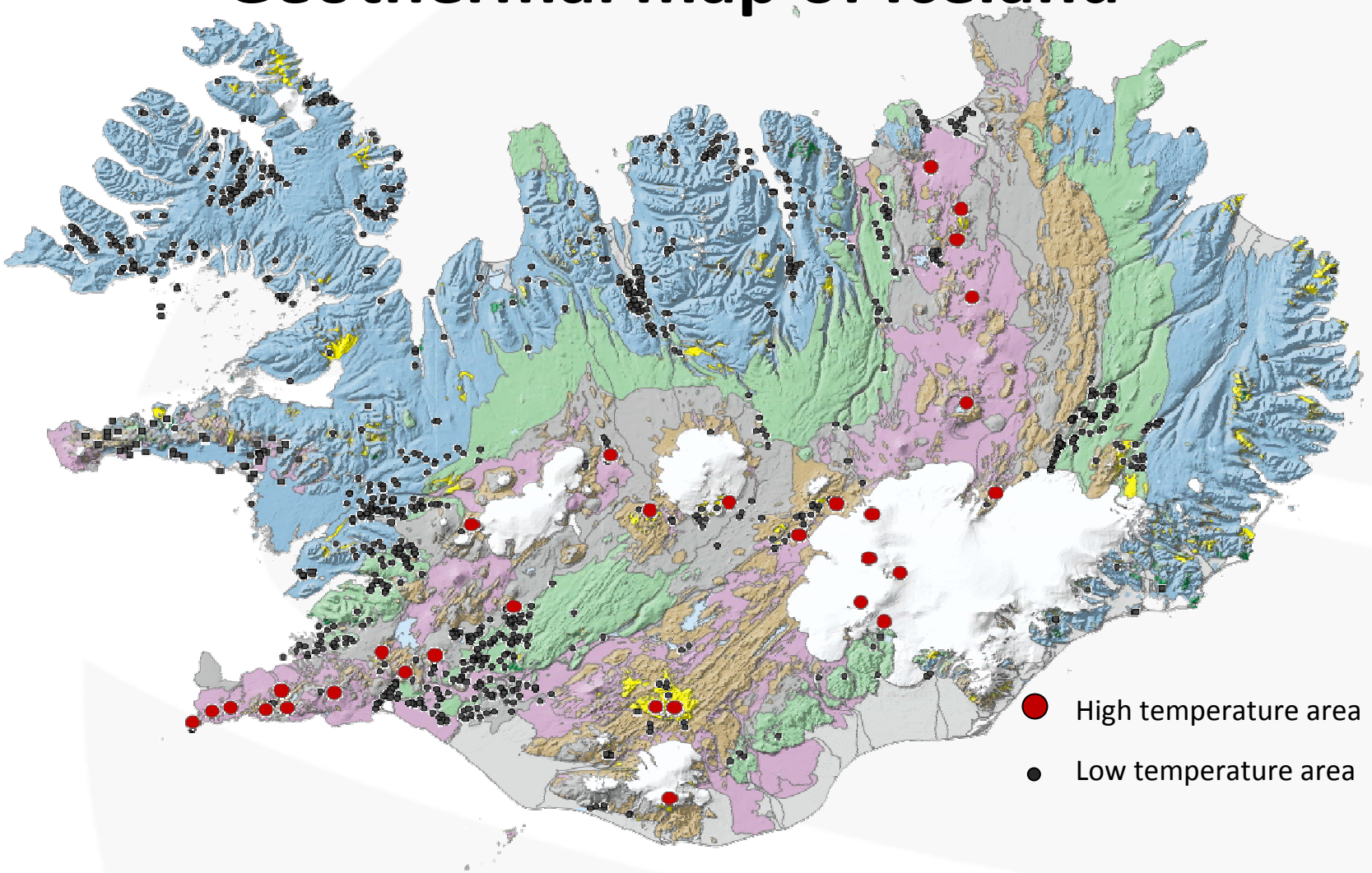
ARGeo 2008, Entebbe, Uganda
Peter E. Danielsen

ICELAND GEOSURVEY

Outline

- Iceland – a short introduction
- HT instruments
  - Historical view of mechanical and electronic instruments
  - Comparing the logging hardware
  - Data quality and resolution
  - Continuous on-edge improvement
- HT logging services
  - Slick-line units and slick-line failure
  - Safety and contingency plans
- Conclusions

Geothermal map of Iceland



Basemap: Geological map of Iceland by Haukur Jóhannesson and Kristján Sæmundsson 1999. Iceland, 1:1.000.000. Icelandic Institute of Natural History.

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Mechanical instruments

- Clock driven Amarada and Kuster mechanical tools
- Obtaining maximum readings of either T or P
- The main source to obtain readings until the 1960's
- Simple, sturdy and reliable
- Repair "in-house"

The K10 Strain instrument

- Battery driven electronic HT Strain sensor tool (10), which measures temperature and pressure (T corrected) simultanously
- Today >95% of HT measurements are done with the K10 tools
- Experience has shown that though the K10 is superior in many aspect, it is still nessesary to keep the mechanical tools for very demanding circumstances
- Extensive wear

K10	Properties	Mechanical
Small (especially in deviated well)	**Robustness**	Very good
To short experience to tell	**Lifespan**	Very long
Essential	**Computer**	Not essential
Very good (1/2m. Interval at 30m/min.) (1sec. In pump-tests)	**Data resolution**	Poor (normally measurements are taken every 100m)
Easy -> guided through ->> less likely to fail	**Tool preparation**	Easy -> NOT guided through ->> more likely to fail
Easy and fast	**Data handling**	Easy but time consuming
2km well: ~9 quarter 3km well: ~14 quarter	**Measuring time down and up**	2km well: ~12+6 quarter 3km well: ~18+9 quarter
2 (both T and P)	**Number of sensors**	1 (either T or P)
~3 weeks (at 5sec. sampling interval)	**Longest measuring time**	48 hours (120 hours clocks available)
~$250	**Cost per run**	~$20
30	**Maximum speed (m/min.)**	~100
0-400	**T range (°C)**	0-470
$25.000	**Price; one tool all incl.**	$7-8.000
6,2 runs (-> 12.400m)	**Turn a profit (based on a 2km well)**	3,8 runs (-> 7.600m) 3,8 runs (-> 7.600m)

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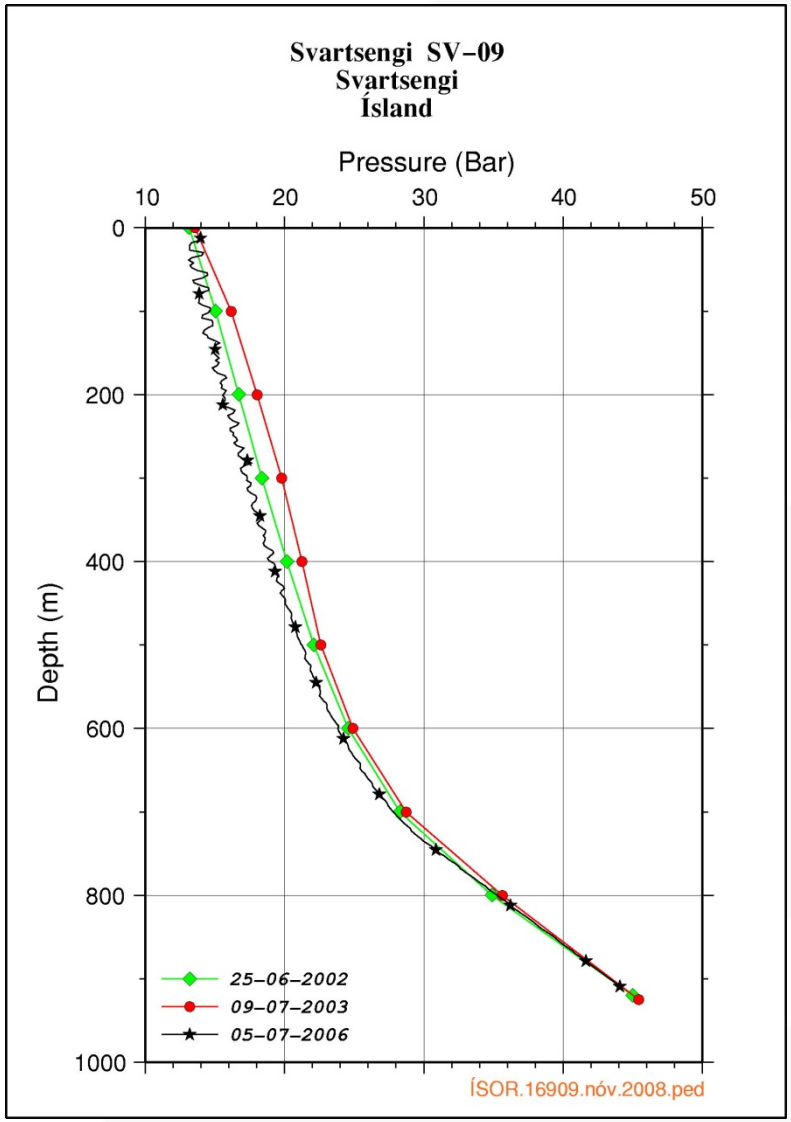
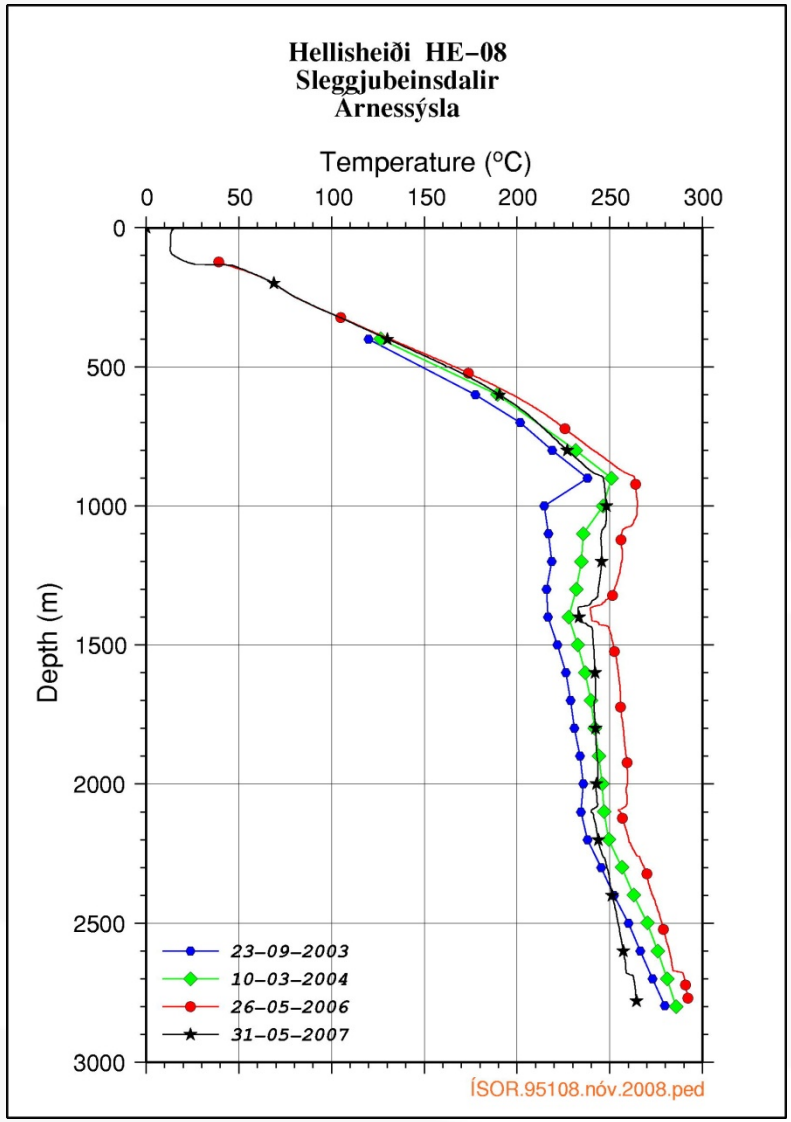
Tool comparision





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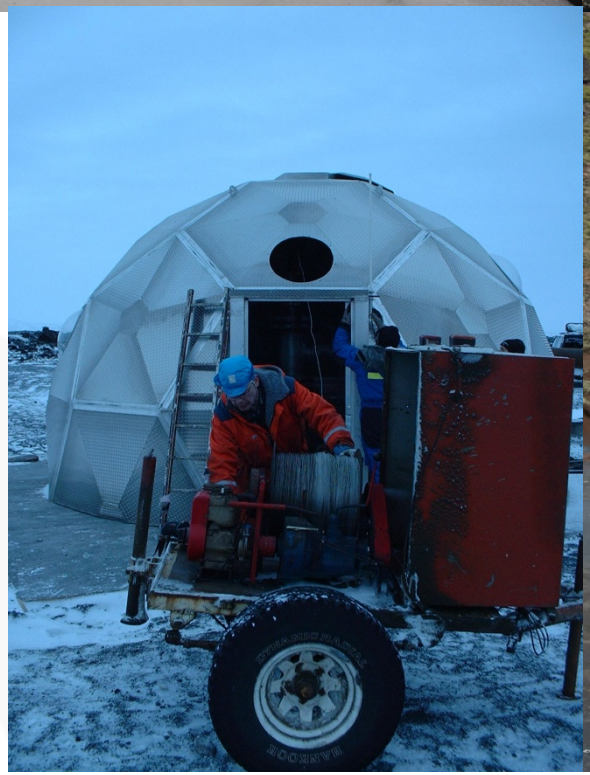

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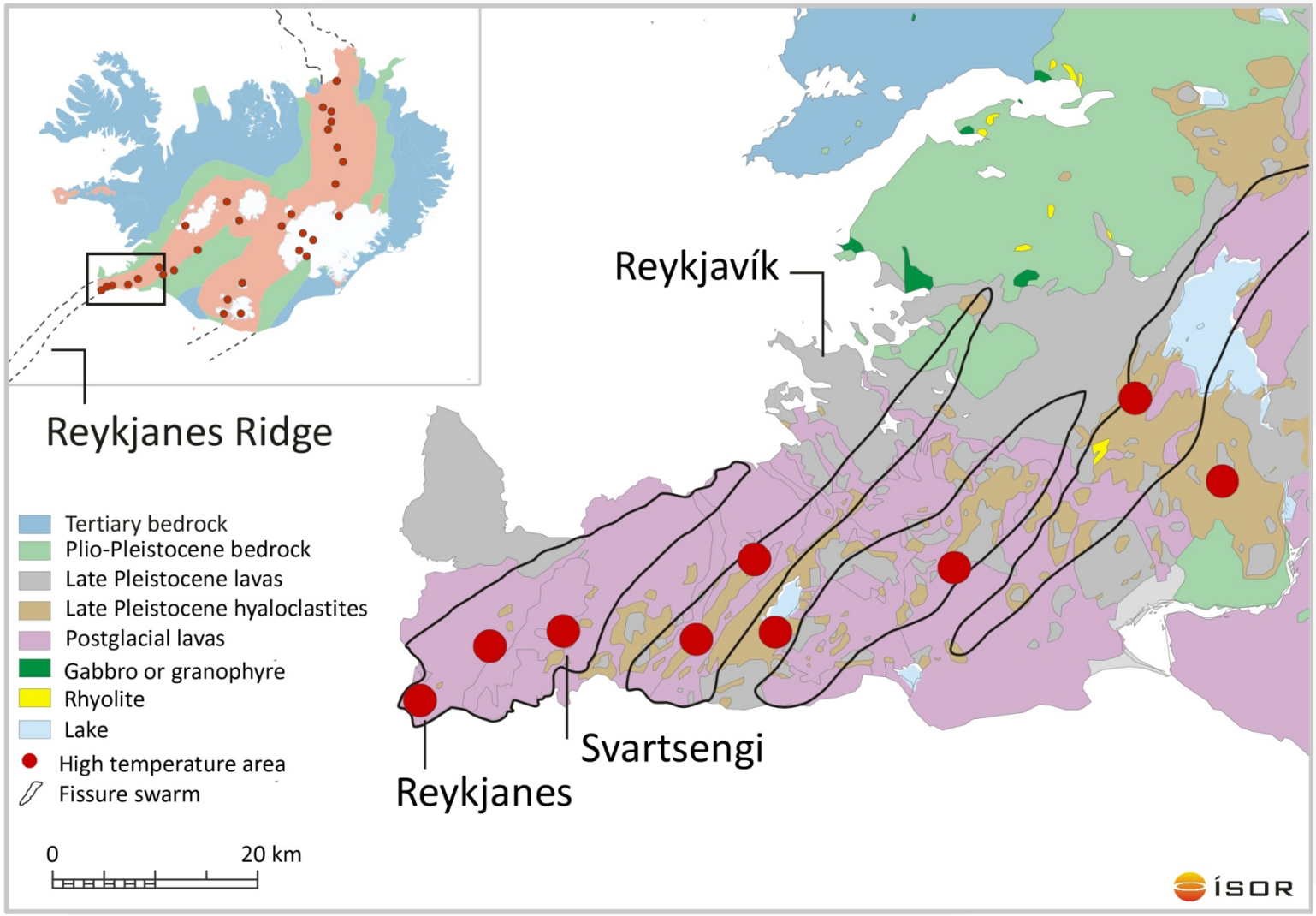
Reykjanes peninsula



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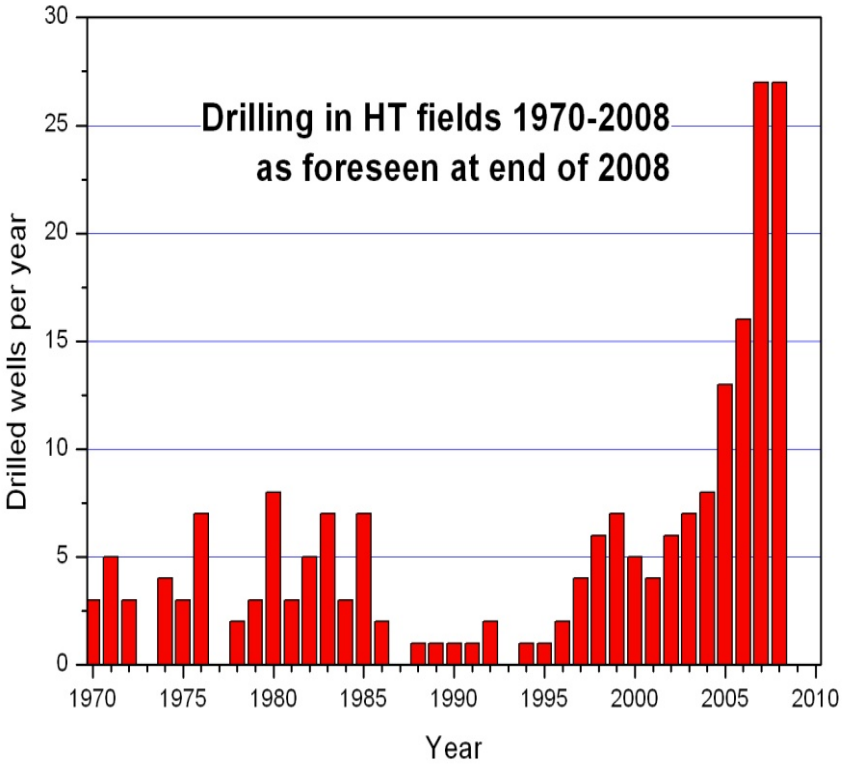
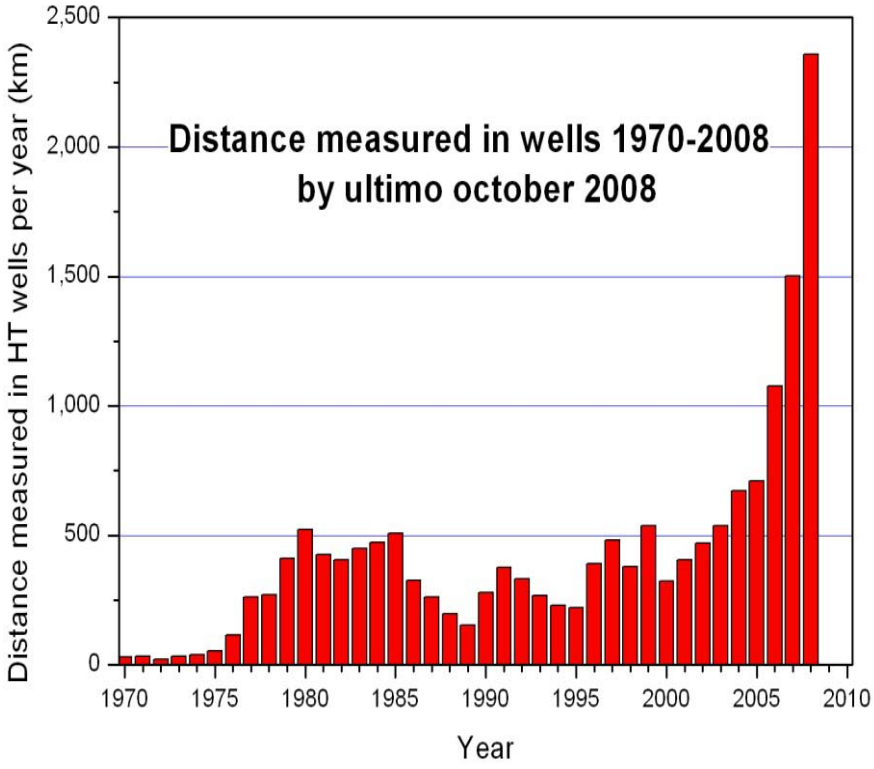
Distances drilled and measured





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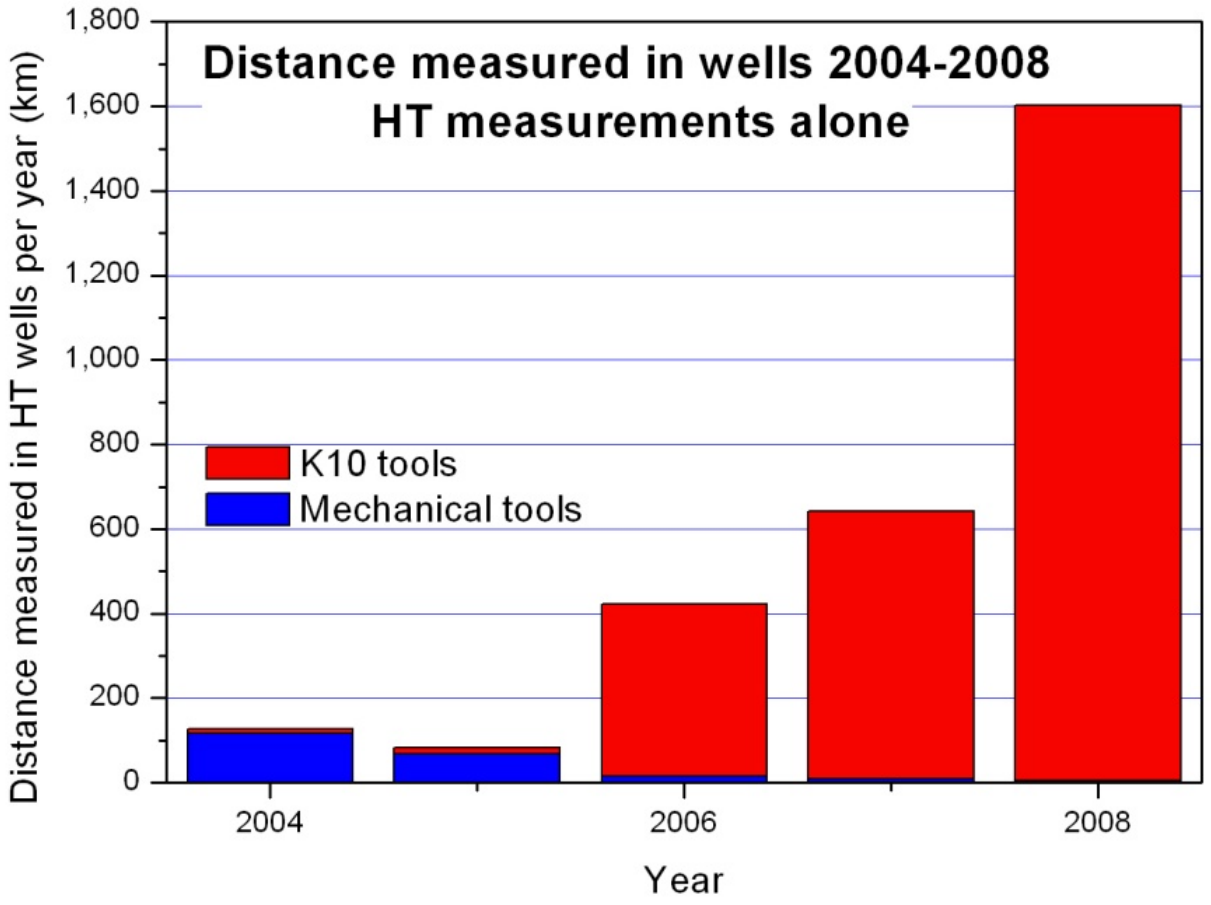
Distances measured – solely HT



Safety and planning ahead

- Safety
  - Success criteria
  - Maintainance
  - Conditions, weather - wellhead
- Contingency plans
  - Planning ahead
  - Malfunction, fishing
- Customer contact
  - Contact with supplier / client
  - Enhancing performance and reliability

Conclusions

- Choosing the right tool for the application
  - Electronic superior
  - Saves time and money
  - Mechanical still necessary though
- Good communication
  - Always room for improvement
  - Open dialogue and candid feedback
  - Pushing tool limits to improve end-product
- The criteria of success
  - Safety – a stand-alone factor of success
  - Contingency plans
  - Customer contact – early abroad

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Takk
fyrir !
Well
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