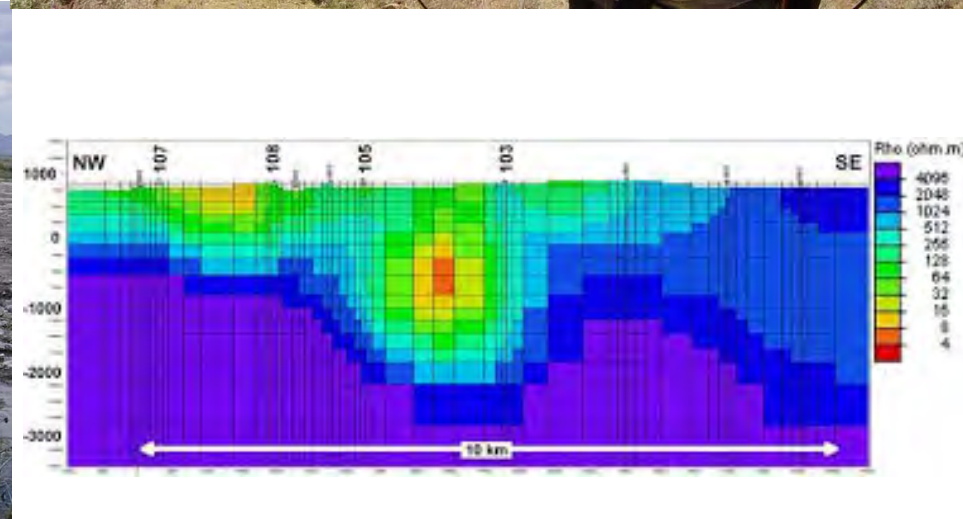
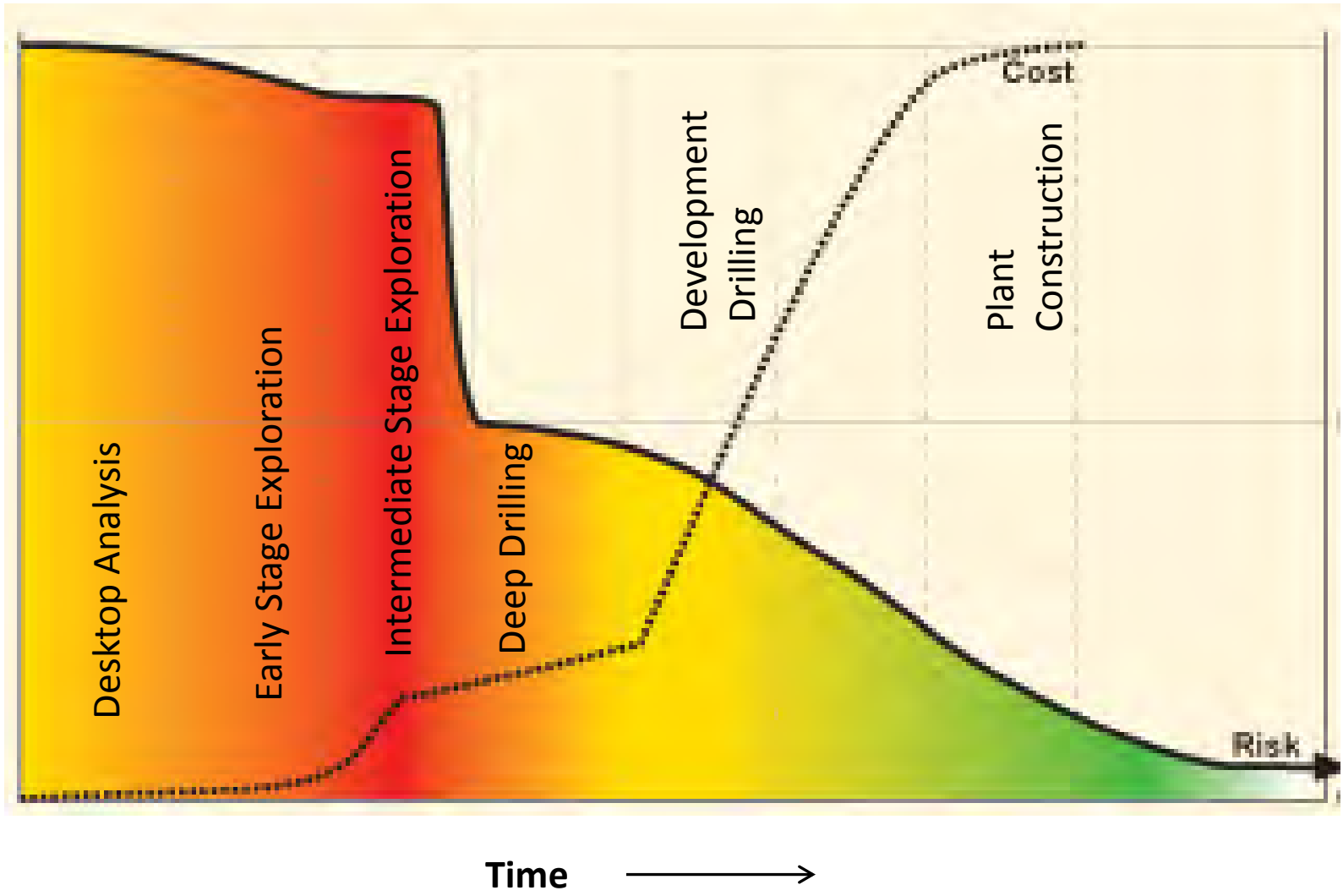


Early-Stage Data Acquisition as a Factor in Resource Risk

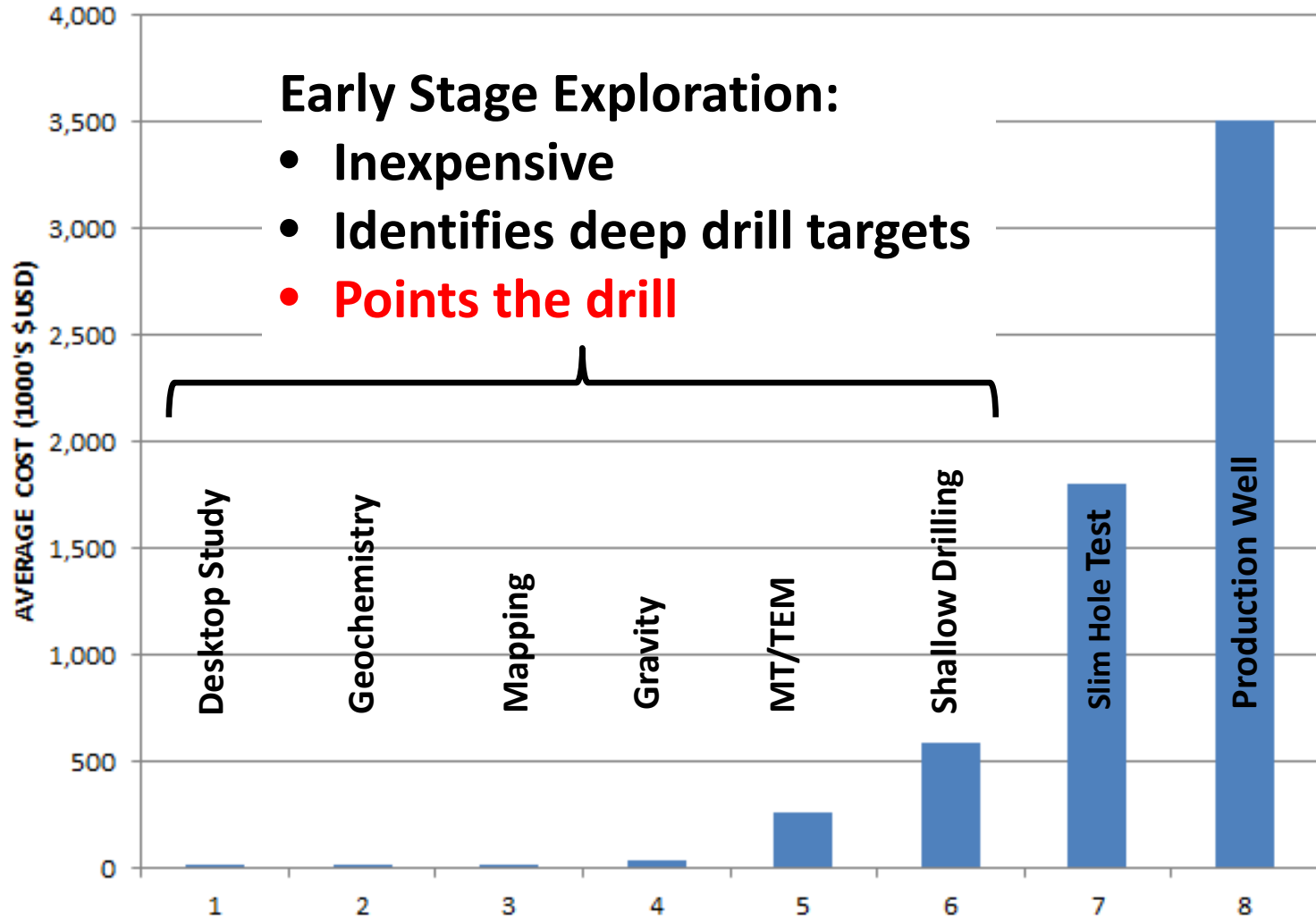


Richard "Rick" Zehner
Geothermal Development Associates
October 23, 2014



*Modified from 2012 ESMAP Geothermal Handbook

Exploration Costs



Poor Early-Stage Sampling Technique:

Geochemical Sampling

- Erroneous reservoir temperatures (geothermometry).
- Poor prediction of scaling potential in pipes and turbines.

Structural/Geologic Mapping

- Don't know whether permeability is primary or secondary.
- Can't relate lost circulation zones to geology.
- Can't predict location of critically stressed fault segments.

Magnetotelluric (MT) Surveys

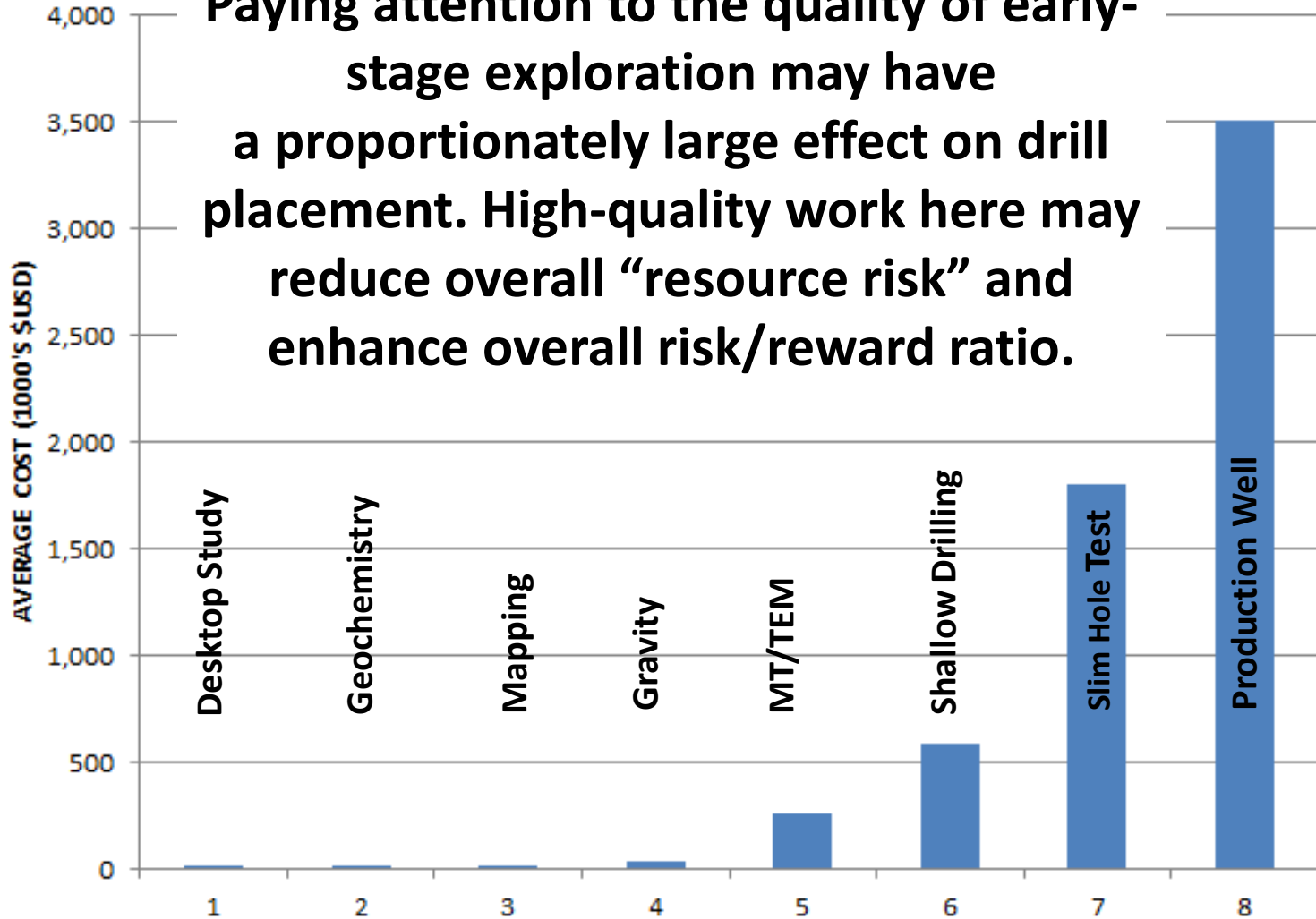
- Problems interpreting depth to the “clay cap” and reservoir.
- Noise outweighing signal, especially at depth, leading to false resistivity “anomalies”.
- Poor drill placement.

Keys to Early-Stage Exploration Success:

- Establish sampling protocols.
- Reduce sample variance
- Document important information (metadata).
- Calibrate equipment before each survey.
- Add duplicate samples and blanks.
- Use one data set to test another.
- Continually upgrade your geologic model as additional data arrives.
- Adopt *GEA Best Practices for Risk Reduction*

MAIN POINT

Paying attention to the quality of early-stage exploration may have a proportionately large effect on drill placement. High-quality work here may reduce overall “resource risk” and enhance overall risk/reward ratio.





Thank you!

And thanks to their great pool of knowledge:

Mark Coolbaugh

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