

A New Approach For Determining Oil Shale Reserves

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World Oil-Shale Deposits

- 409 billion tonnes in-situ shale
- 2.8 trillion barrels of shale oil
(Based on Fischer assay)

“Most oil shales produce shale oil that ranges in density from about 0.85 to 0.97 by the modified Fischer assay method.”

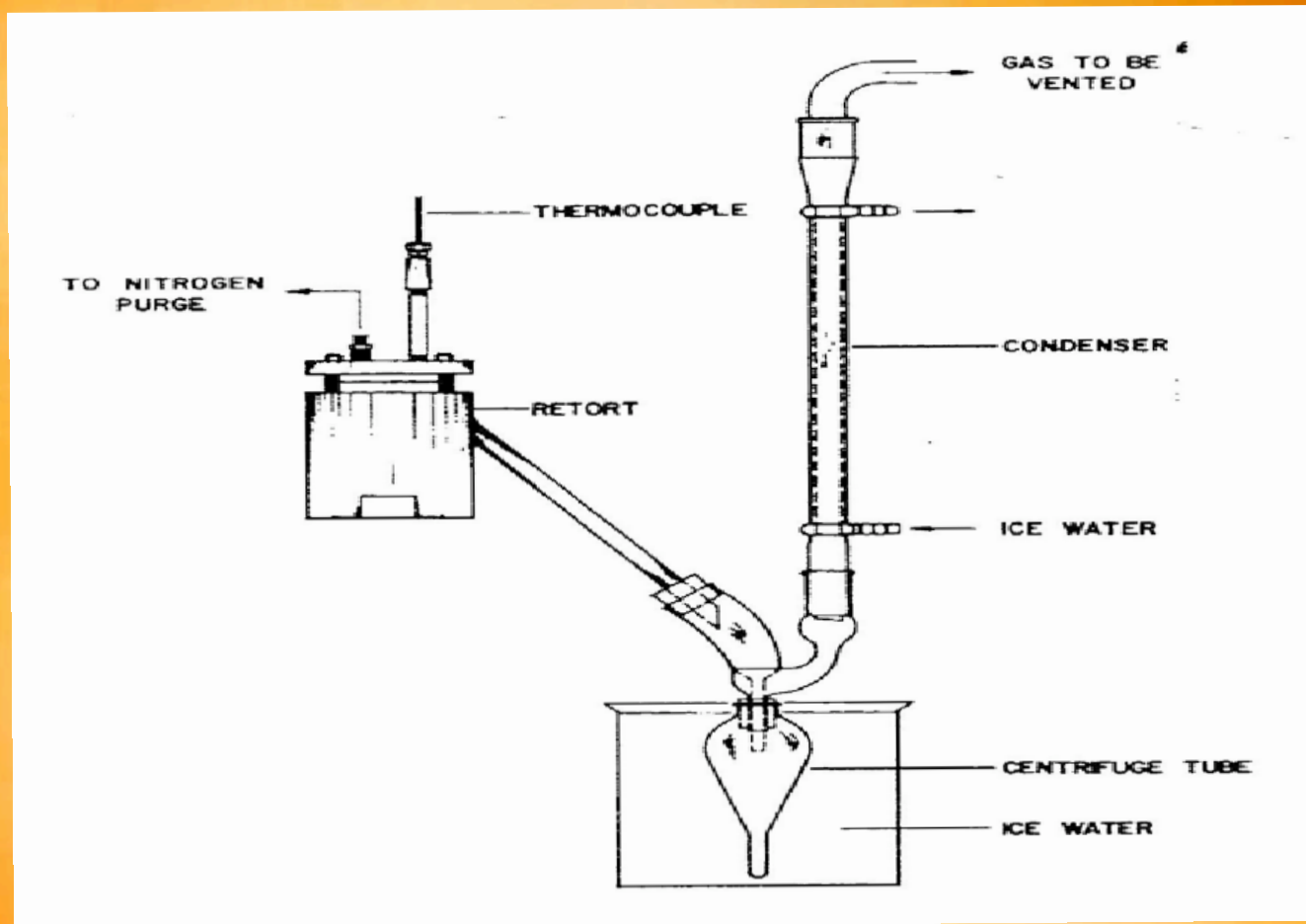
USGS Report

“The Fischer assay method also does not necessarily indicate the maximum amount of oil that can be produced by a given oil shale.”

Fischer Assay

- Developed in Germany in 1930s for coal industry, adapted in 1940s by USBM for oil shale
- Industry standard (ASTM D-3904-80 withdrawn)
- Procedure:
 - 100 g of oil shale ground to -8 mesh
 - Heated to 500°C at 12°C/min and hold for 40 minutes
 - Ice trap of vapors
 - Calculate yield by weight of recovered oil, water, shale residue and "gas plus loss"

FA Apparatus



Fischer Assay Issues

- Yields do not reflect conversion approach
- Oil quality not indicative of final product after hydro-processing

Fischer assay
consistently understates
potential oil reserves

Alternative Assay Techniques

- Total Organic Carbon
- Nuclear Magnetic Resonance
- Density
- Easily Oxidized Material

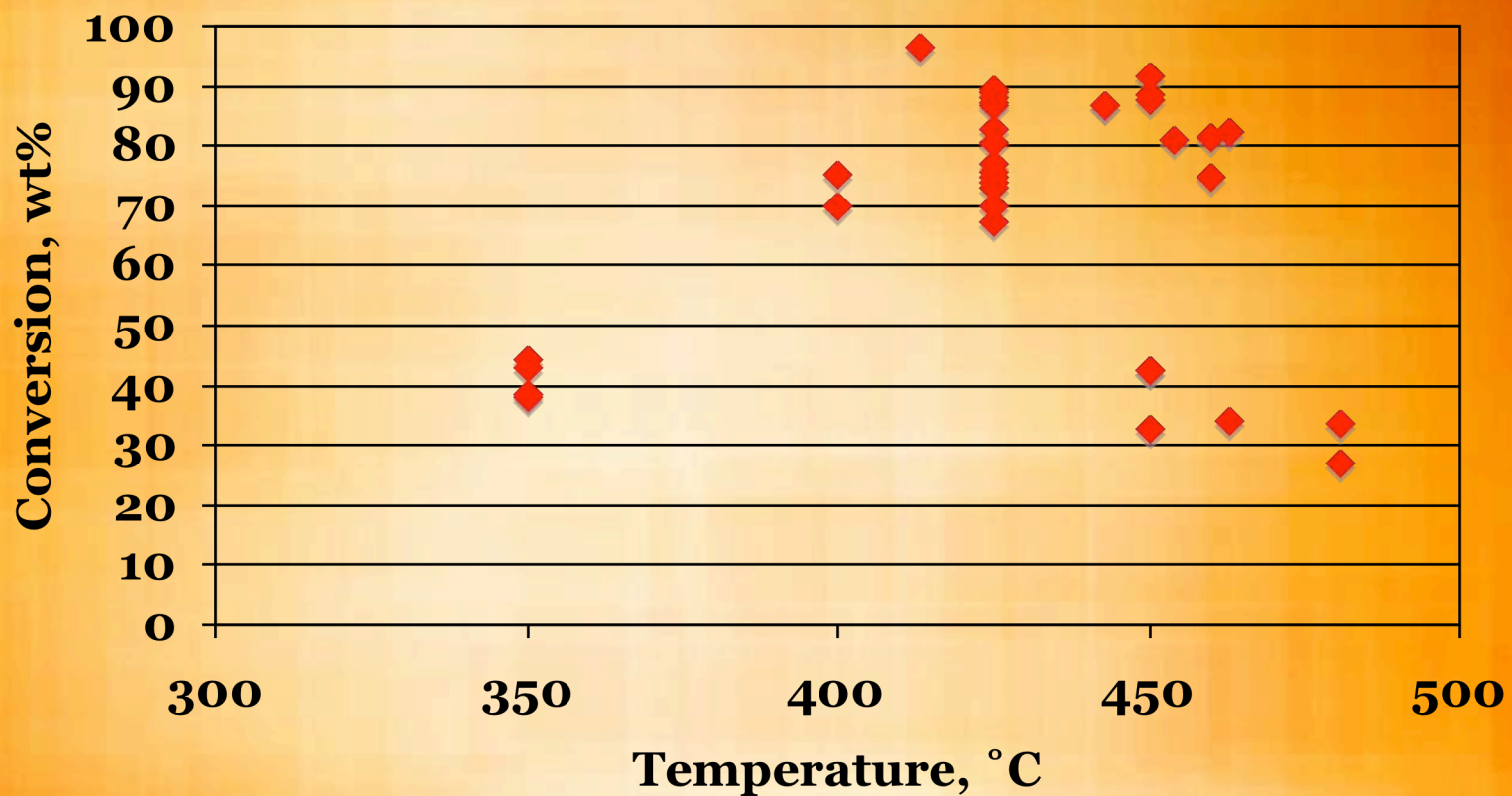
All require new correlation for
each deposit or geologic age

What Is Needed?

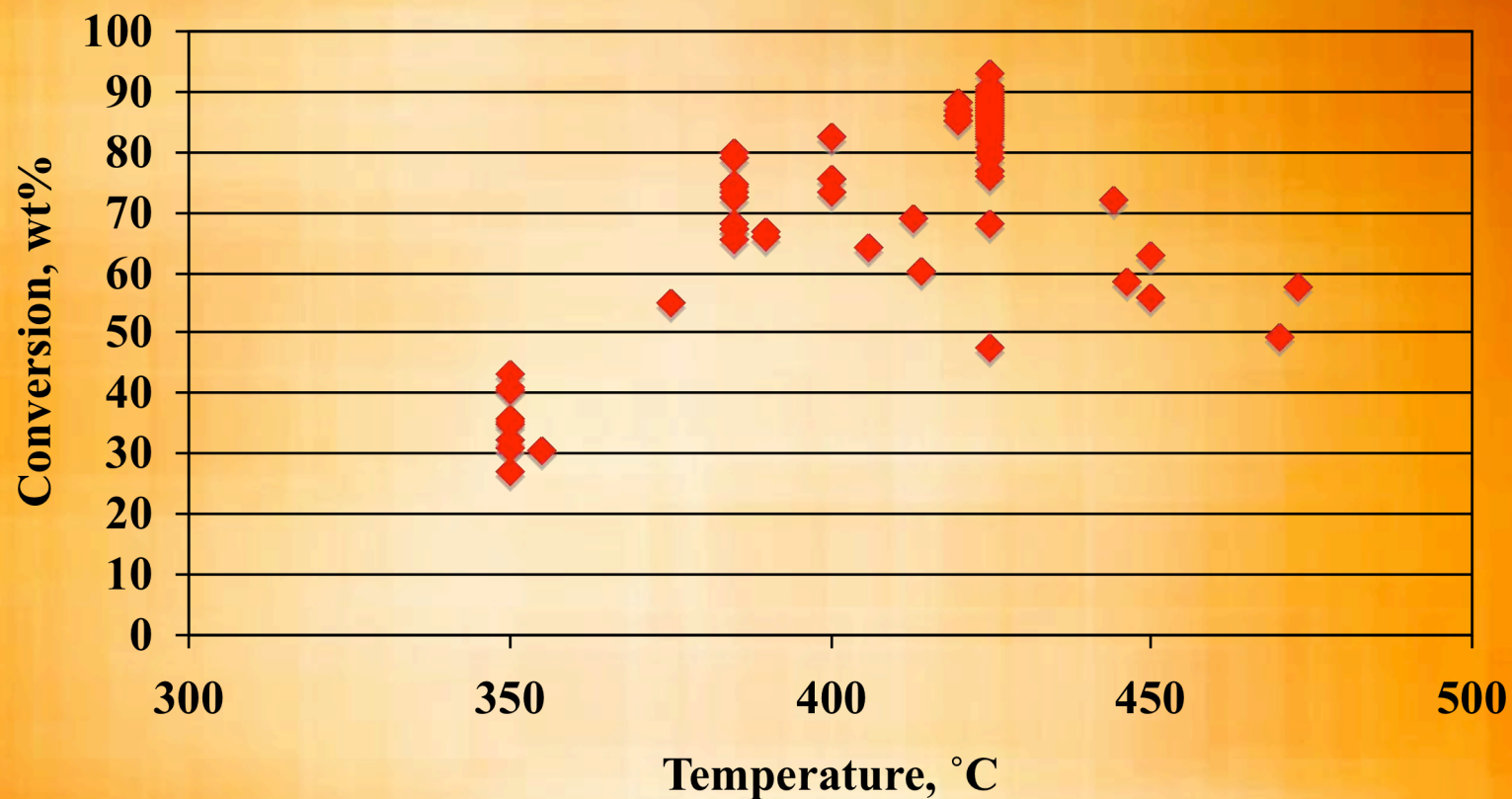
- Laboratory method that provides estimate of potential oil quality and yield regardless of commercial process
- Consistent approach that accounts for hydrogenation of oil

Need a method that pyrolyzes and adds hydrogen to conversion products

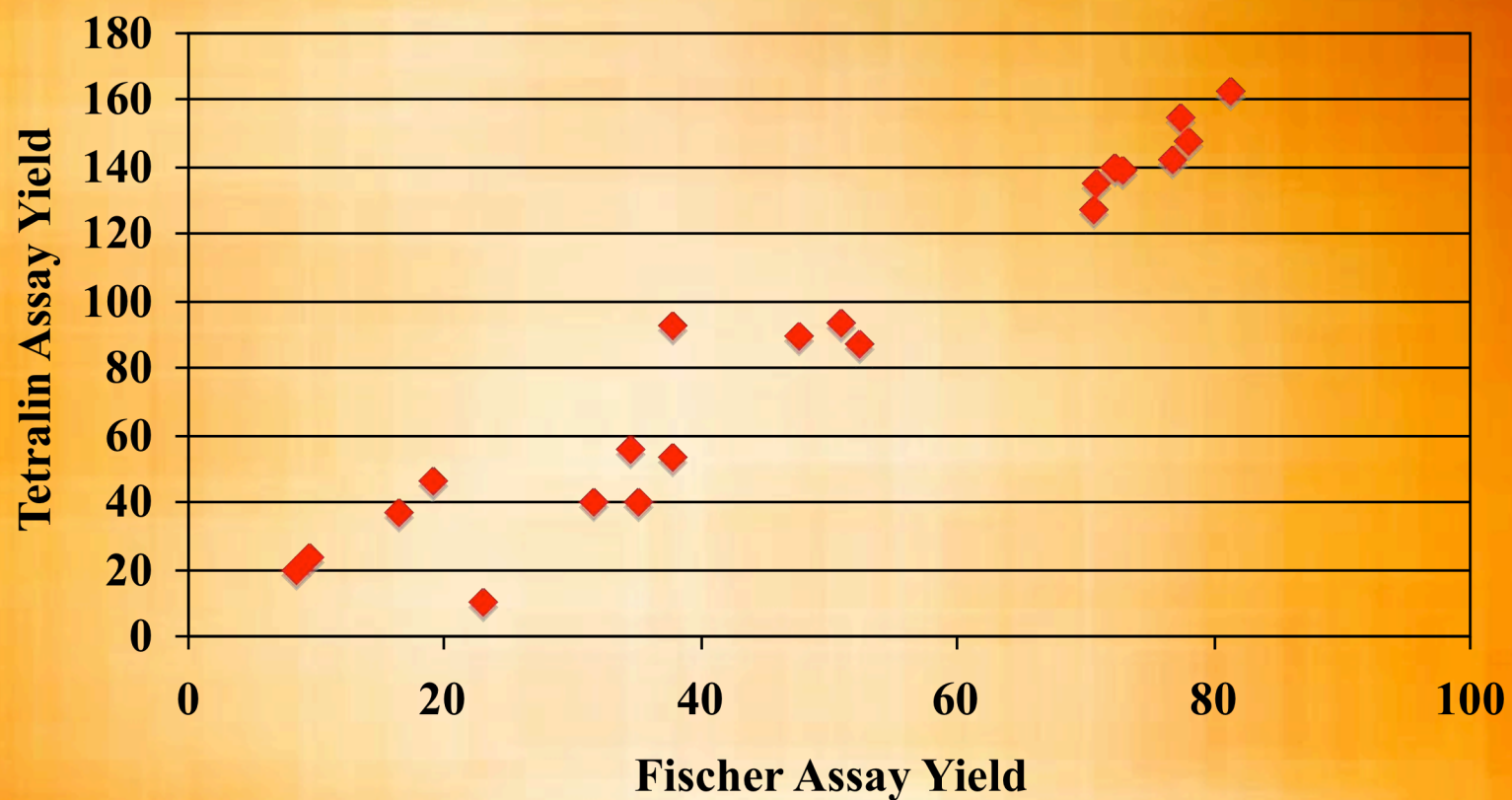
Pyrolysis At 800 psig Under Hydrogen



Pyrolysis 300-1500 psig with Tetralin



Correlation Of Tetralin With Fischer Assay



Conclusions

- High pressure pyrolysis of oil shale in the presence of hydrogen or tetralin can achieve >90% kerogen conversion
- Final product oil quality can be more accurately estimated

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Reserve estimates should be independent of oil shale conversion method

Thank You

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