

# Chromatographic Investigation of Oil Shale Derived Diesel Fuel Properties

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Oil Shale Symposium  
*Golden, CO*



# Acknowledgements

NREL thanks Shell (Unconventional Oil)  
for providing fuel samples

# Project Overview

- Oil shale properties have been previously reported (1980s)
- State of technology has changed as have fuel quality standards
- Renewed interest in domestic fuel sources for petroleum security
- Two oil shale samples were analyzed using chromatography and spectroscopy
  - Results were confirmed with ASTM property testing

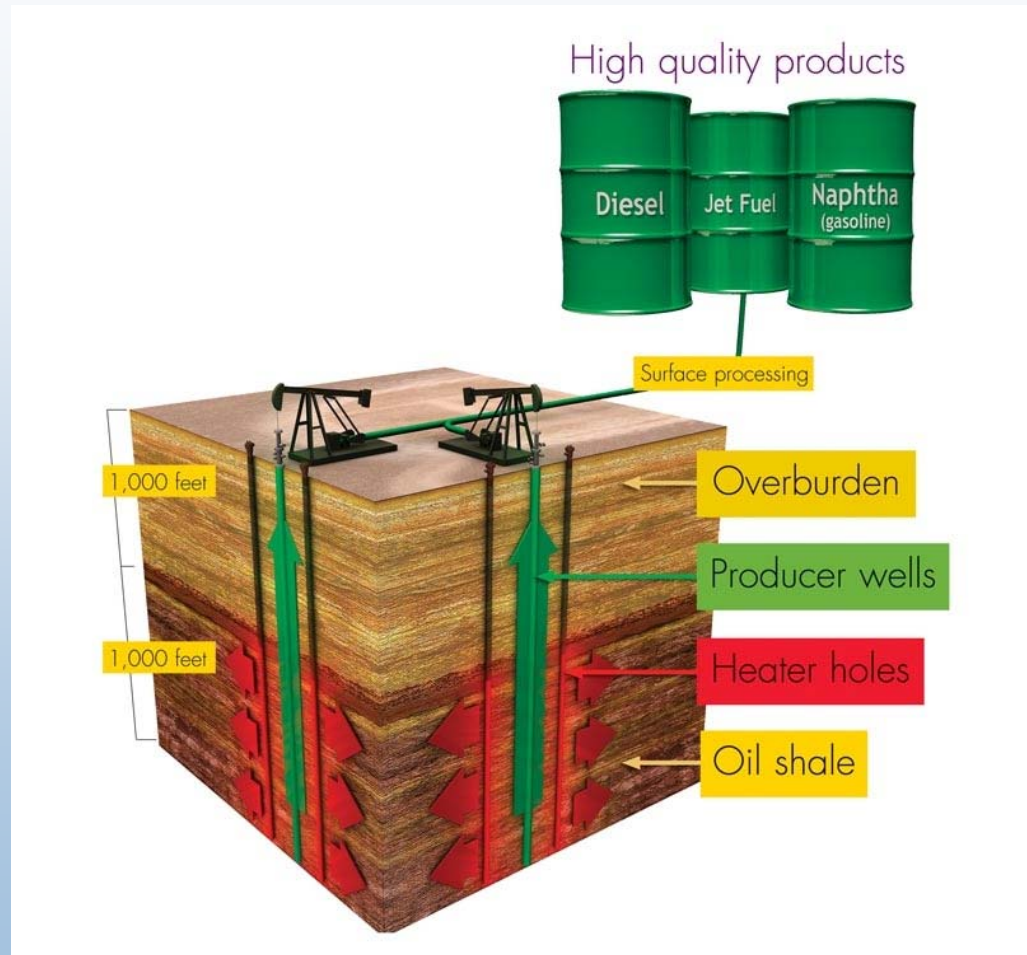


# Nomenclature

- GTL: gas-to-liquid diesel fuel produced through Fischer-Tropsch process
- No.1 and No.2: Petroleum derived diesel fuels meeting applicable ASTM D975 properties
- Cert diesel: Federal Emission Certification diesel fuel
- Normal ULSD: Oil shale derived diesel fuel
- Unwaxed ULSD: Oil shale derived diesel fuel

# Shell Oil Shale Production Overview

- Electric heaters gradually heat shale beneath surface
- Heat converts kerogen in the oil shale into oil and gas
- Results in a high recovery of light hydrocarbon products yielding high quality transportation fuels

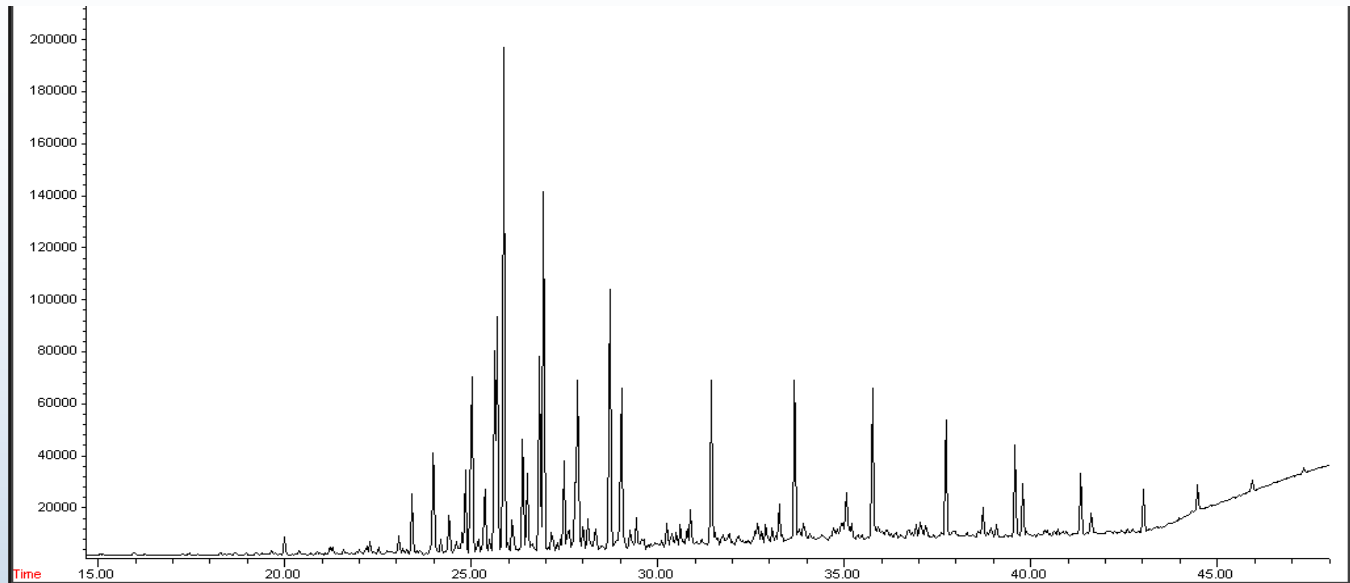


# GC/FID Analysis

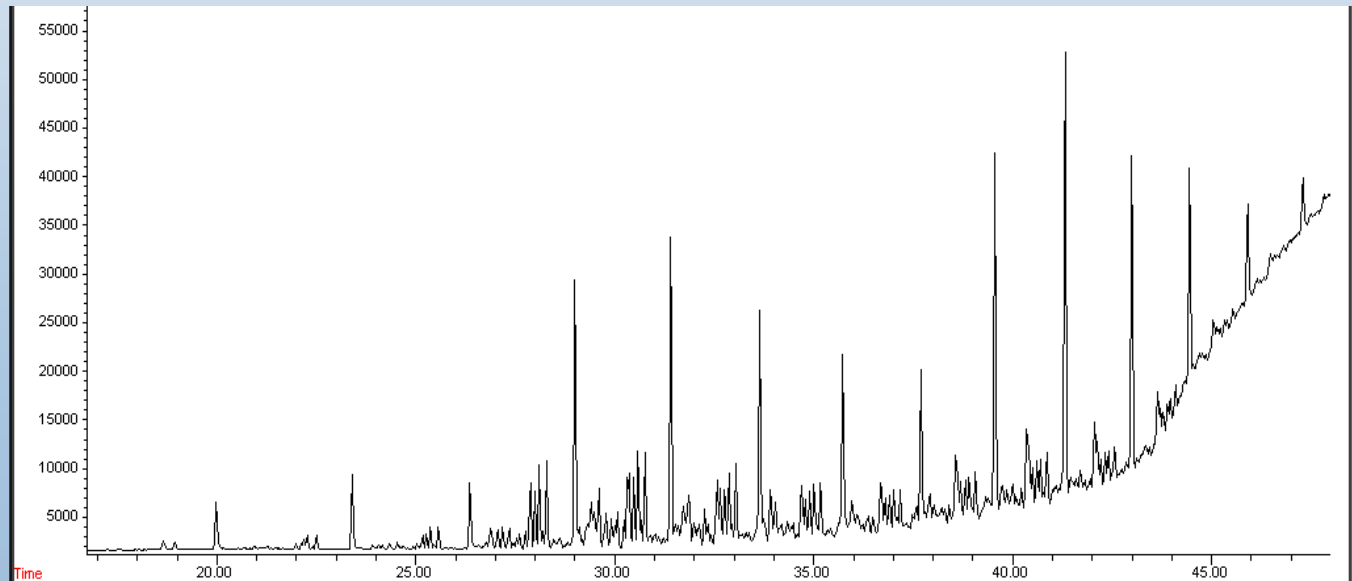
- DB-1 column
  - 60m, 0.32mm, 1mm film
- 40°C initial temperature, 1 min hold
- 7°C/min to 230°C
- 10°C/min to 325°C, 10 min hold
- Splitless injection (360°C)
- FID (325°C)

# Quantitative GC Results

Cert Diesel

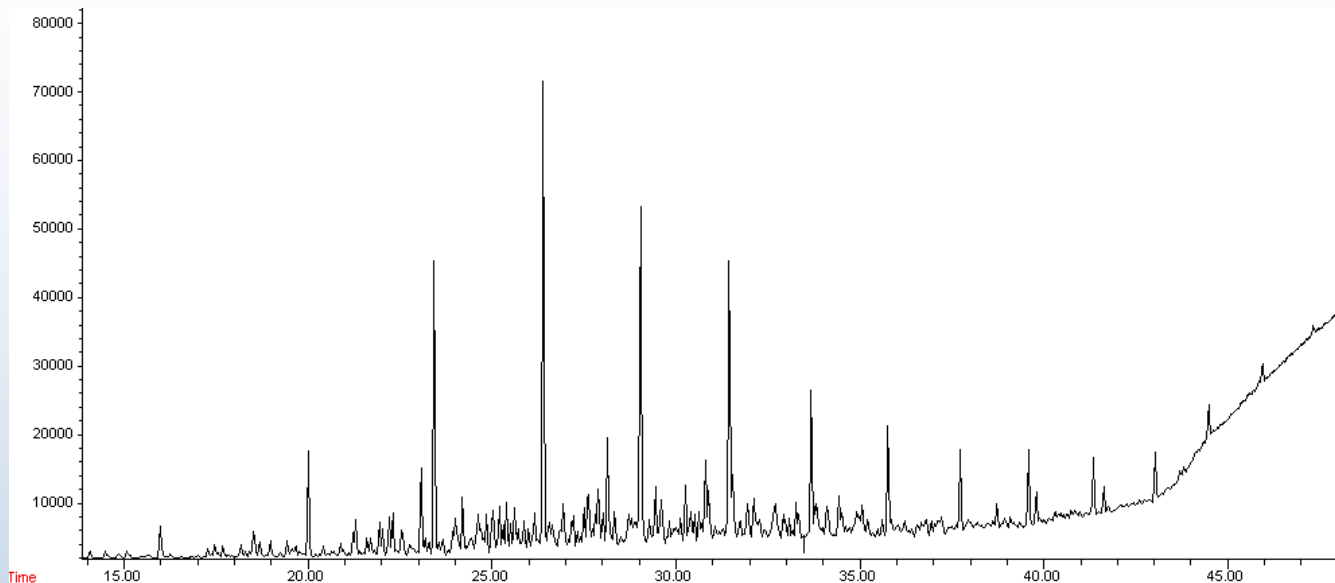


GTL Diesel

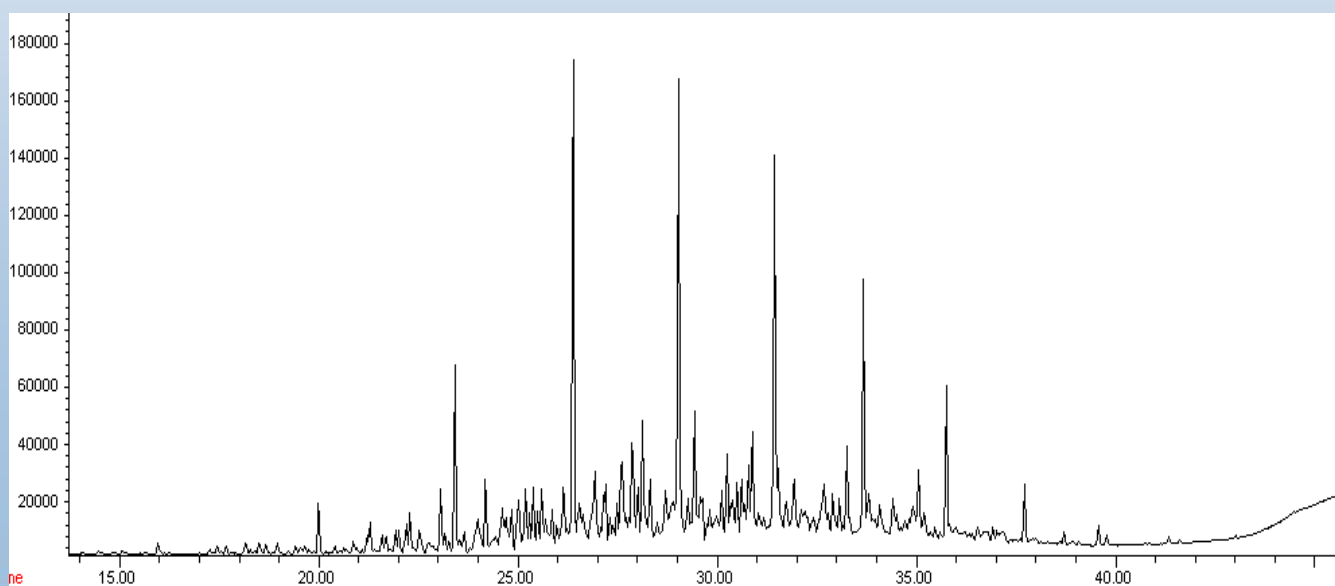


# Quantitative GC Results

No.2 Diesel



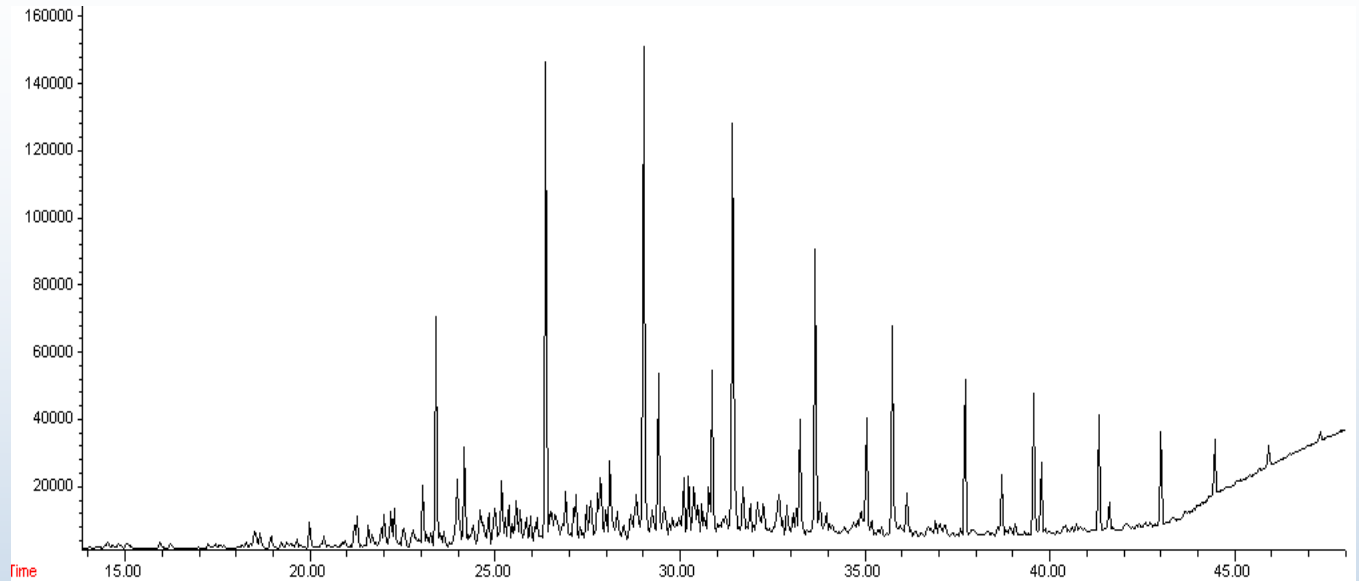
No.1 Diesel



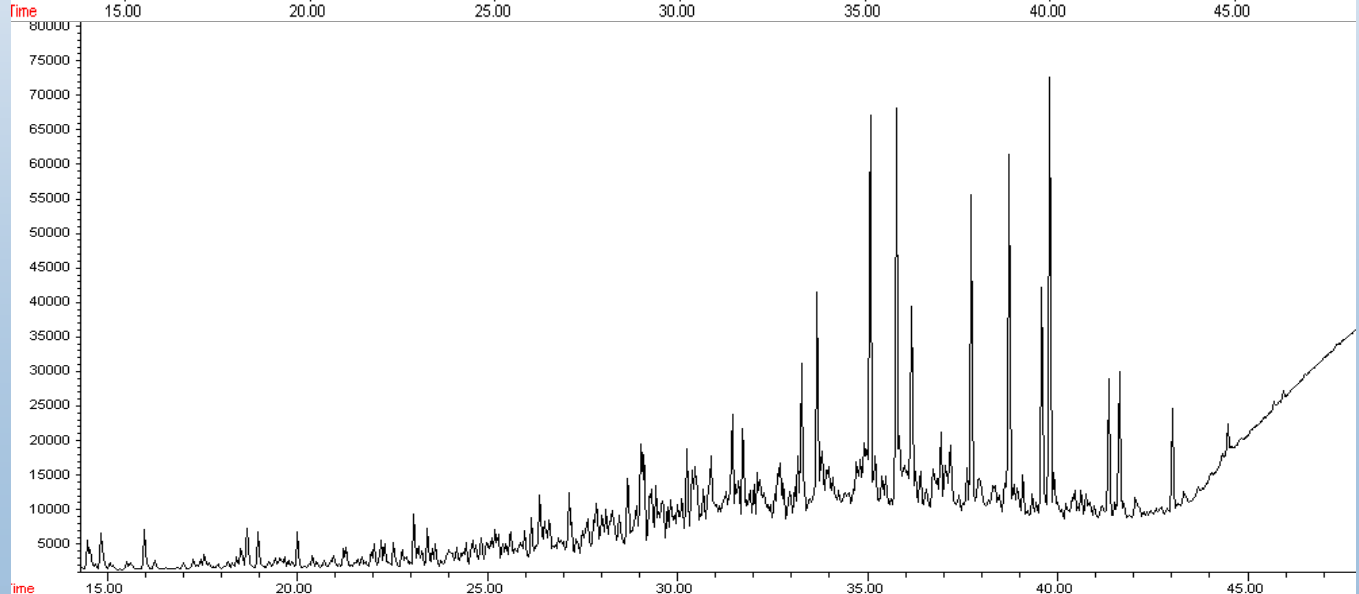


# Quantitative GC Results

Normal ULSD  
(Oil Shale)



Dewaxed ULSD  
(Oil Shale)

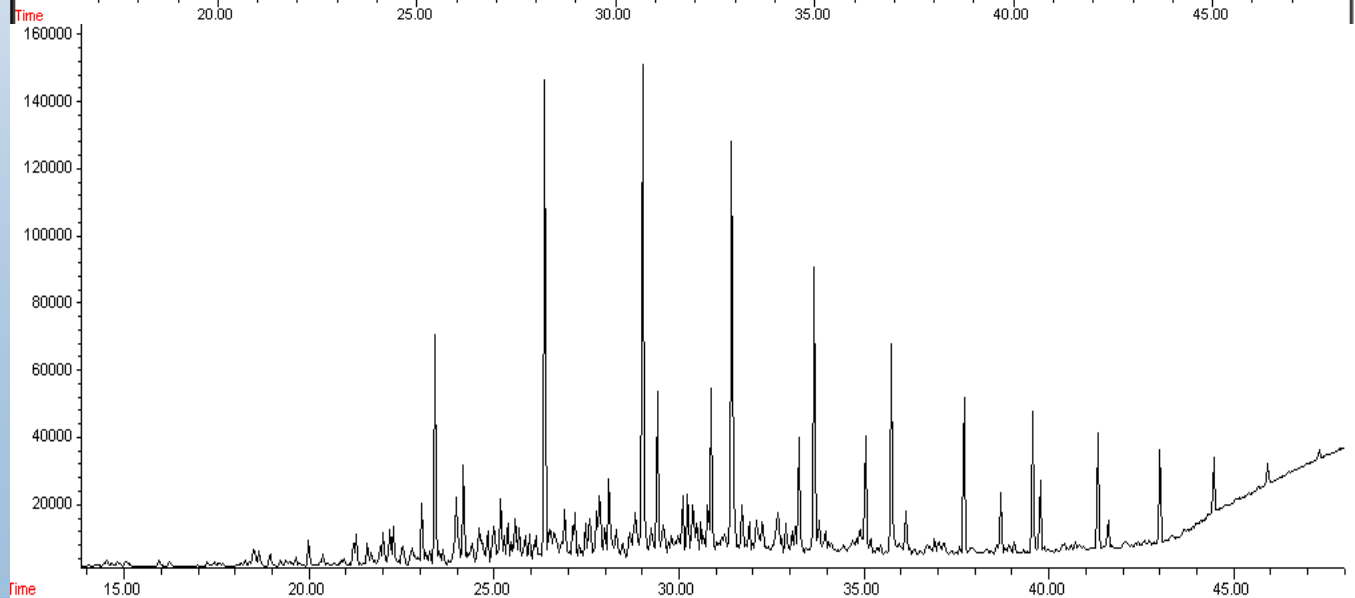
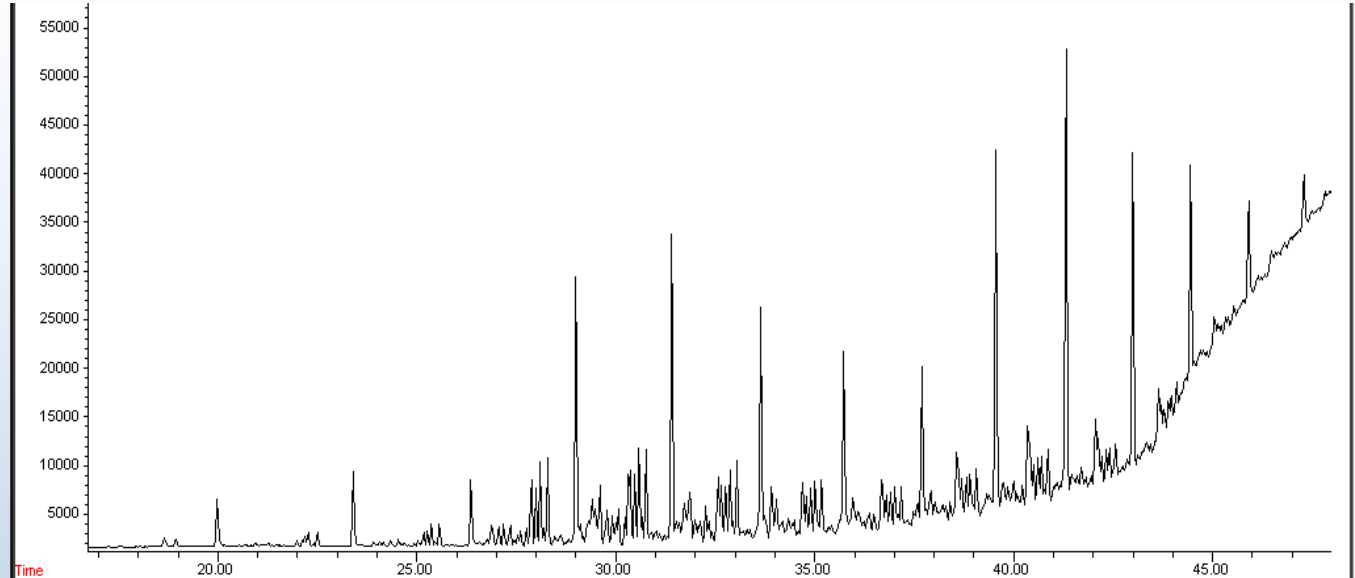


# Key Points of GC Analysis

- Paraffin and aromatic compounds observed
- Distinct paraffinic patterns in GTL fuel
  - Similar patterns in Normal ULSD (Oil shale)
- Conventional diesel fuels and oil shale fuels show peaks between paraffinic patterns
  - Aromatics and/or branching/isomerization

# GTL Compared to Normal ULSD (Oil Shale)

GTL Diesel



Normal ULSD  
(Oil Shale)

# NMR Analysis

- Lots of CH, CH<sub>2</sub>, and CH<sub>3</sub> shifting
- Aromatic hydrocarbons in all fuels except GTL fuel
  - Monoaromatics observed as well
- Dewaxed oil shale has more branching than Normal oil shale
- Less CH<sub>2</sub> groups in Normal oil shale
  - Shorter chains => lighter fuel

# ASTM Property Testing

Test	Normal ULSD	Dewaxed ULSD	No.2	GTL
Aromatics, vol% (D1319)	12.6	8.2	24.4	1.0
Olefins, vol%	1.6	1.4	1.8	1.0
Saturates, vol%	85.8	90.4	73.8	98.0
Total Aromatics, mass% (D5186)	15.4	9.7	28.2	1.4
Monoaromatics, mass%	14.8	8.6	23.6	1.4
Polyaromatics, mass%	0.8	1.2	4.6	<0.1
LHV, BTU/lb (D240)	18,673	18,581	18,322	20,246
C/H ration (D5291)	1.99	1.98		2.13
Sulfur, ppm (D5453)	2.7	1.0	4.5	0.5
Ash content, mass% (D482)	<0.001	<0.001	<0.001	<0.001

# Closing Remarks

- Two oil shale derived diesel fuels were compared to conventional diesel fuels
- Broad similarities between fuels
  - Distillation ranges, homologous paraffinic series, aromatics and varying degrees of branching
- Normal ULSD is a lighter fuel, but Dewaxed ULSD has higher degree of branching in hydrocarbon compounds
- Results were confirmed by ASTM tests