

Sulfur: From Big Bang to Big Boom and Its Importance to the Alberta Economy

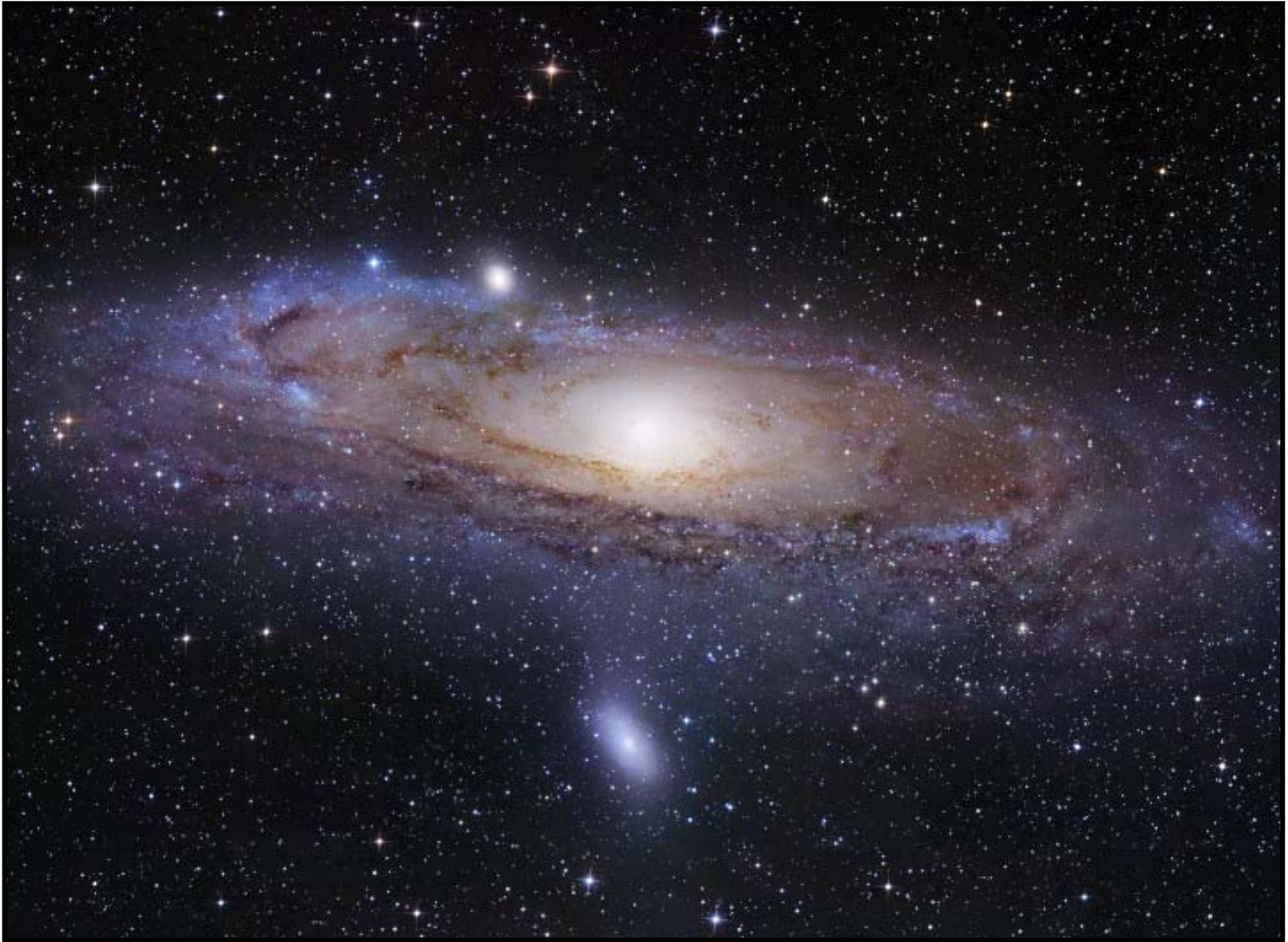


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Spiral Galaxy



View of the Earth from the Space



Some Important Elements in the Periodic Table

hydrogen 1 H 1.00794(7)					helium 2 He 4.002602(2)
lithium 3 Li 6.941(2)	beryllium 4 Be 9.012182(2)				boron 5 B 10.811(7)
sodium 11 Na 22.989770(2)	magnesium 12 Mg 24.3050(8)		carbon 6 C 12.011(7)	nitrogen 7 N 14.00644(7)	oxygen 8 O 15.9994(3)
			fluorine 9 F 18.9984032(3)	neon 10 Ne 20.1797(6)	aluminum 13 Al 26.981538(6)
			silicon 14 Si 28.0855(3)	phosphorus 15 P 30.973761(2)	sulfur 16 S 32.06(6)
			chlorine 17 Cl 35.4527(2)	argon 18 Ar 39.948(1)	

- Sulfur – twice as abundant as carbon in the earth's crust
- Sulfur – without it, our metabolism ceases
- Sulfur – without it, no H₂SO₄, no fertilizer
- Sulfur – linked in nature to the carbon cycle

Oil and gas utilization

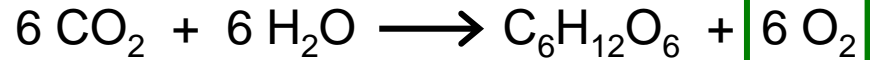


excess sulfur

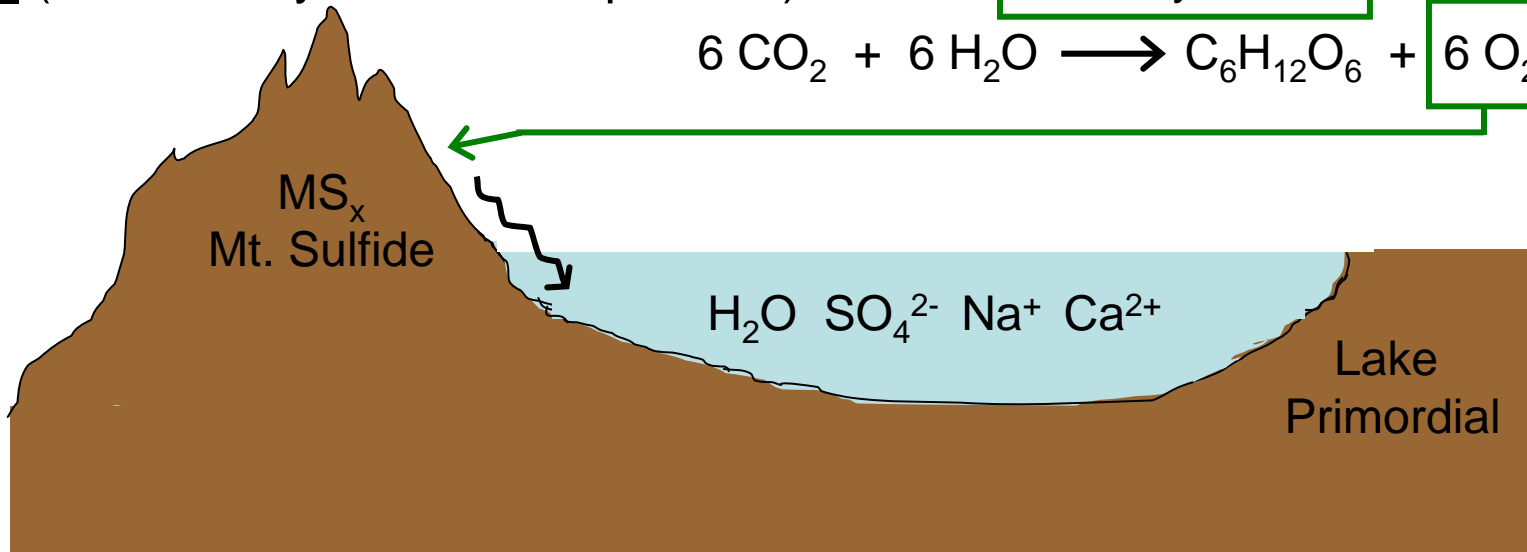
The Origin of H₂S in a Sour Gas Reservoir

Time Scale (Billions of years before present)

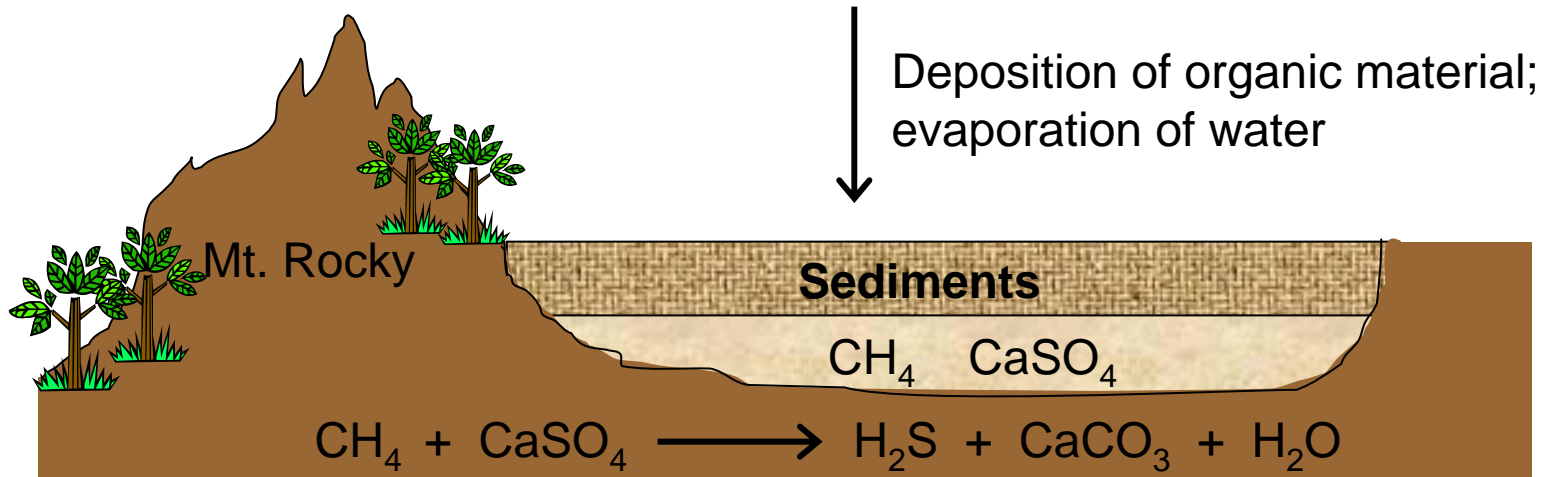
Photosynthesis



3.5 - 0.5



0.5 - 0.05



- Sour gas (CH₄ / H₂S) is found in carbonate reservoirs

Various Hydrocarbon Reserves in Alberta

Alberta



* Coal deposits underlay approximately two thirds of South Central Alberta

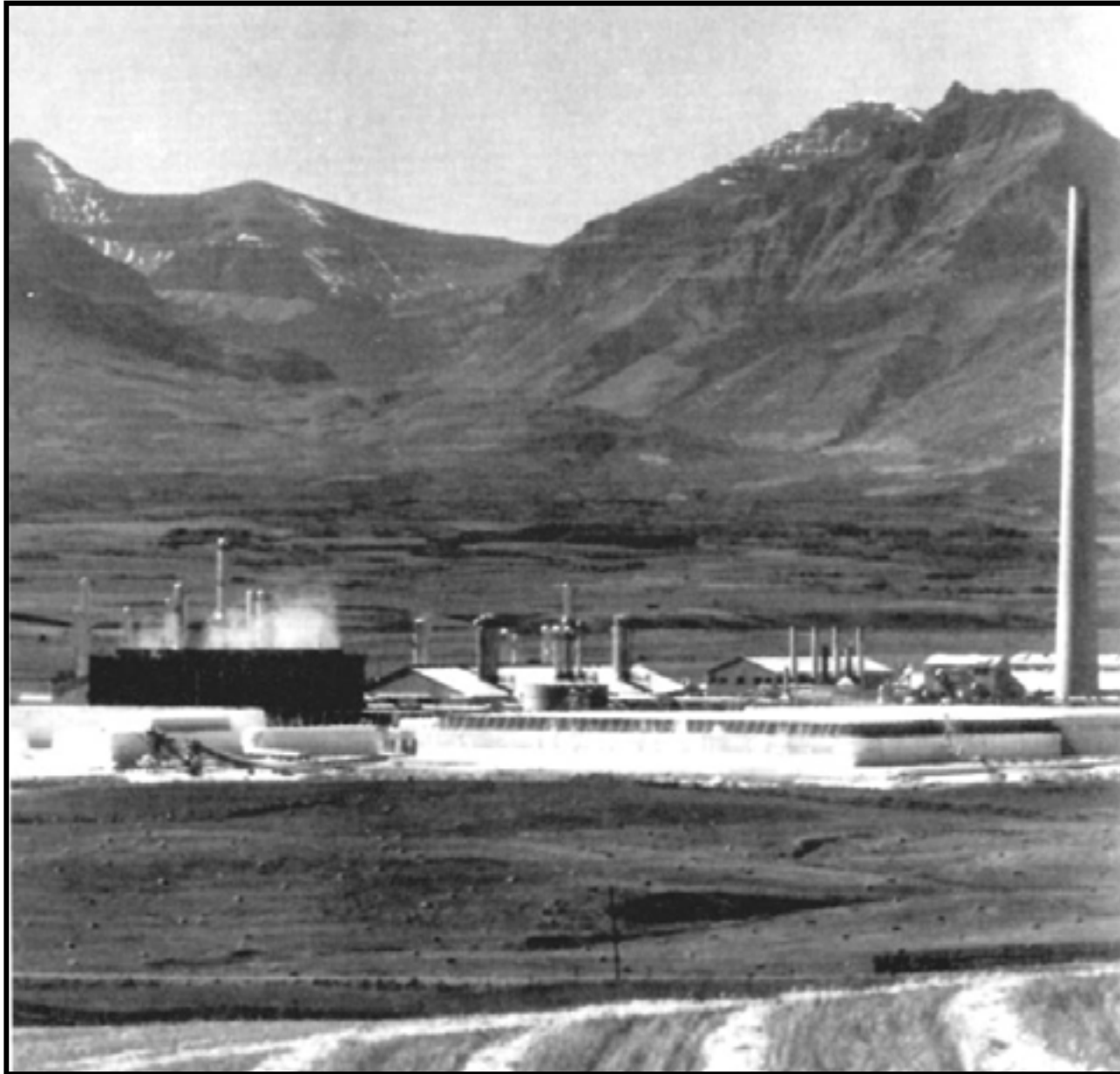
- > 50,000 ton S₈ / day by 2025



Development of Sulfur Technology in Alberta

- 1920's • Turner Valley oil: H_2S off-gases
- 1950's • Sour natural gas discoveries and exploitation (CH_4 , H_2S , CO_2)
- 1960 – 1980 • The era of the super-size sour gas plant
1,000 – 4,000 tons of sulfur per day
- 1970 – 2000 • Alberta controls the world sulfur export market
with 40% share
- 1960 – 2007 • Super-sour gas [H_2S 50 – 90%]; waiting in the wings
- 1975 – 2007 • Oil sands bitumen: the next avalanche of sulfur
- 1975 → • Export of Alberta sulfur technology

BA Pincher Creek Gas Plant, ca. 1960



Petro-Canada Wildcat Hill (Formerly Canadian Fina)



Petrogas Balzac with Its Twins Smokestacks: Double the Trouble for Stack Testers



The Shell Waterton Gas Processing and Sulfur Recovery Plant

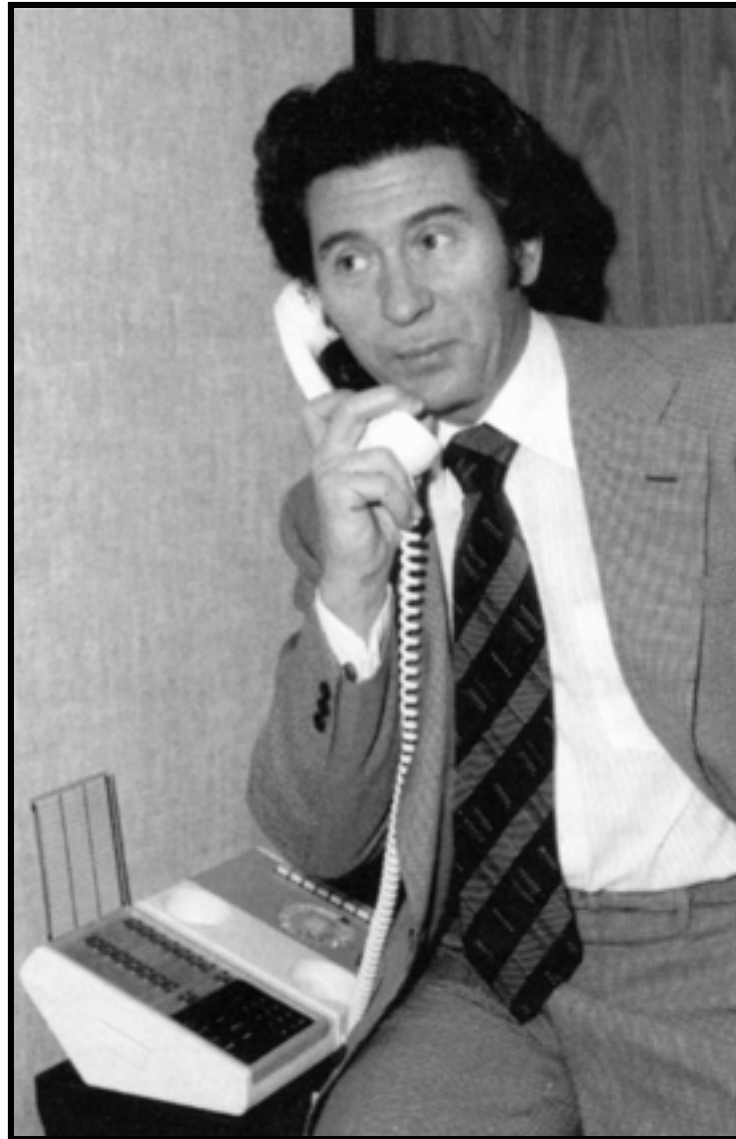


Alberta Entrepreneurship in Sulfur Technology

1964 : Alberta Sulphur Research Ltd., [Professor Jim Hyne,
University of Calgary] Sour Gas Production and Sulfur Chemistry

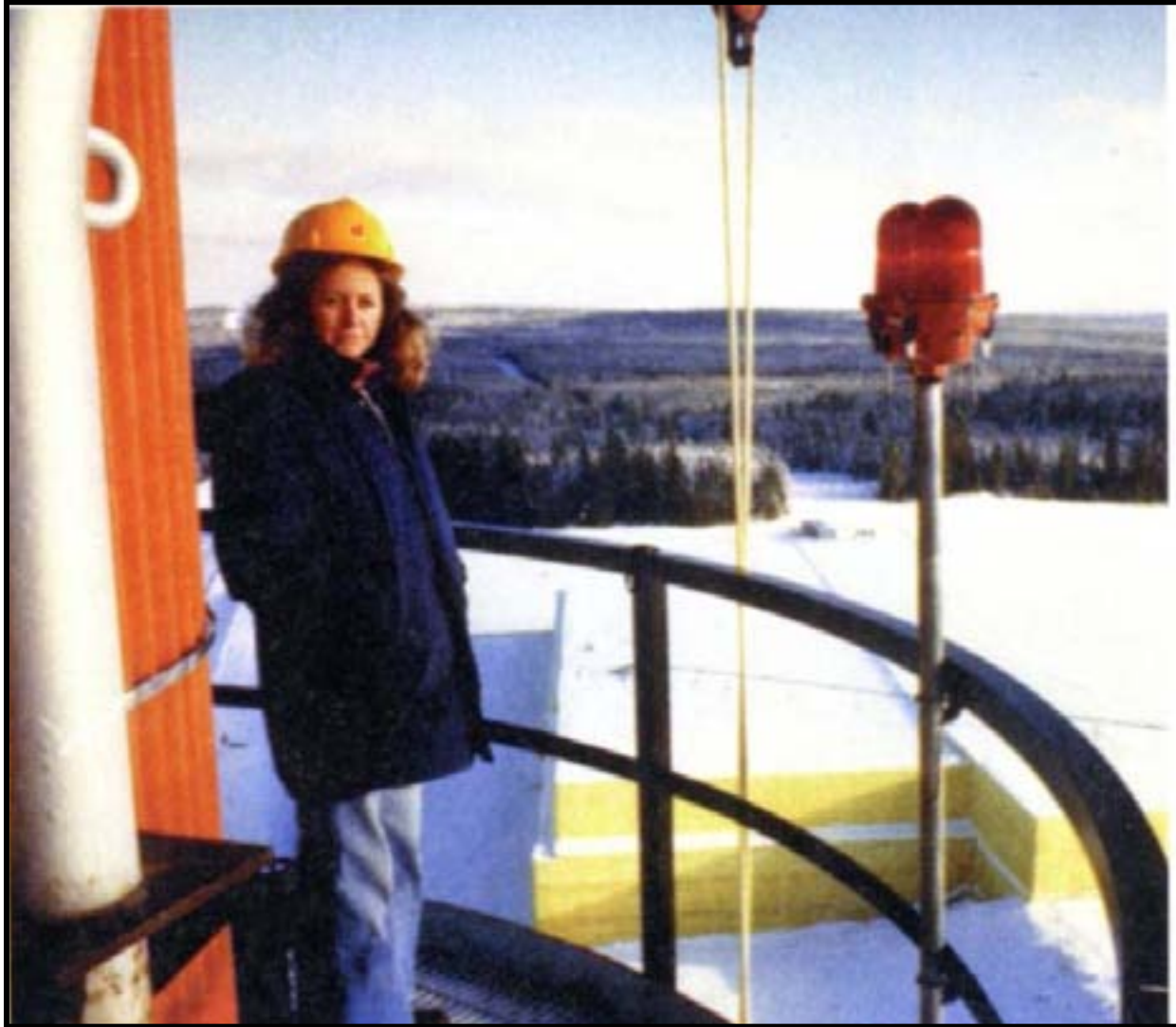


1965 : Western Research and Development: Emissions and Sulfur Plant Testing



Joe Lukacs

Stack Testing [Western Research and Development]



Jackie Hudson

Sultran Ltd.

- Sulfur transportation and export
- Formed in 1975/6 to help the industry market 8 million tons of sulfur each year



Kevin Doyle, Sultran President
1976 to 1997

Rail Transport Through the Rockies



Courtesy: Canadian National Railway Company

Export From Vancouver



Export From Vancouver



Firsts in Alberta Sulfur Technology

1. Large scale sour gas production (10 million tons of H₂S per year) (plus lots of CH₄)
2. Emissions monitoring and pollution control
3. Introduction of high efficiency tail gas processes (> 99% sulfur recovery)
4. Solid sulfur pelletization and distribution
5. Introduction of large-scale liquid sulfur degassing
6. Large scale solid sulfur storage (> 25 million tons in 1980)
7. H₂S disposal by re-injection into depleted reservoirs
8. The world's pre-eminent reservoir of sulfur engineering, chemistry and technology expertise

The Future for Sulfur in Alberta

Alberta

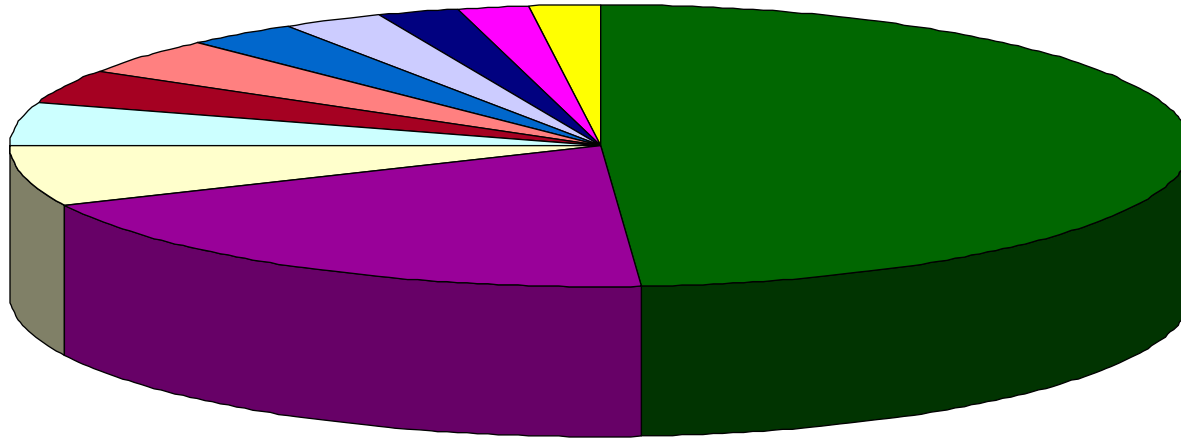


* Coal deposits underlay approximately two thirds of South Central Alberta

- > 50,000 ton S₈ / day by 2025



Sulfur in The World Economy



- 1 Fertilizers 49%**
- 2 Chemicals 19%**
- 3 Other Acid Industries 7%**
- 4 Titanium and Other Pigments 5%**
- 5 Other Non-Acid Industries 4%**
- 6 Pulp and Paper 4%**
- 7 Rayon and Film 3%**
- 8 Carbon Disulphide 3%**
- 9 Petroleum 2%**
- 10 Iron and Steel 2%**
- 11 Insecticides 2%**

Sour Gas Developments Across the World



Arabia
Arab Emirates

- > 50,000 ton S₈ / day by 2025

All could be dwarfed by sulfur from the Alberta Oil sands

Sulfur Research at The University of Calgary

Alberta Sulphur Research Ltd.

Aecomtric Corporation
Air Products & Chemicals Inc.
Ametek Western Research
AXENS
Baker Petrolite
BASF Catalysts LLC
Bechtel Corporation
Black & Veatch Corporation
BP Canada Energy Company
Brimstone STS Ltd.
Canadian Natural Resources Limited.
Canwell Enviro-Industries Ltd.
Champion Technologies Ltd.
Chevron Texaco (Research and Technology)
ConocoPhillips Company / Burlington Resources
Controls Southeast, Inc.
Devon Canada Corporation
EnCana Corporation
Enersul Inc.
ENI Tecnologie - ENI Group
Euro Support BV
ExxonMobil Upstream Research Company
Fairborne Energy Trust
Fluor Corporation
Goar, Allison & Associates, Inc.
HAZCO Environmental & Decommissioning Services
HEC Technologies
Husky Energy Inc.
Innovative Chemical Technologies Canada Ltd. (ICTC)

International Commodities Export Company of Canada Limited (ICEC Canada Ltd.)
IPAC Chemicals Limited
Jacobs Canada Inc./Jacobs Nederland B.V.
Lurgi AG
Marsulex Inc.
Merichem Chemicals and Refinery Services LLC
M-I Drilling Fluids Canada Inc.
Nalco Canada
Occidental Oil and Gas Corporation
Petro-Canada Oil and Gas
Porocel Corporation
Sandvik Process Systems, Inc.
Saudi Arabian Oil Company (Saudi Aramco)/ASC
SemCAMS / Central Alberta Midstream
Shell Canada Limited
SiiRTEC Nigi S.p.A.
Spectra Energy Transmission (SET)
Stecher Proprietary Interests, L.L.C.
Sulphur Experts Inc. (Western Research)
Sultran Ltd.
Suncor Energy Oil Sands Limited Partnership
Syncrude Canada Ltd.
Talisman Energy Canada
Technip France/ KTI S.p.A.
Total
Washington Group International Inc.
Weatherford International LLC
WorleyParsons
Xergy Processing Inc.



Acknowledgment

