

# History of the Alberta Geological Survey and Its Contribution to the Petroleum Industry in Canada\*

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## Abstract

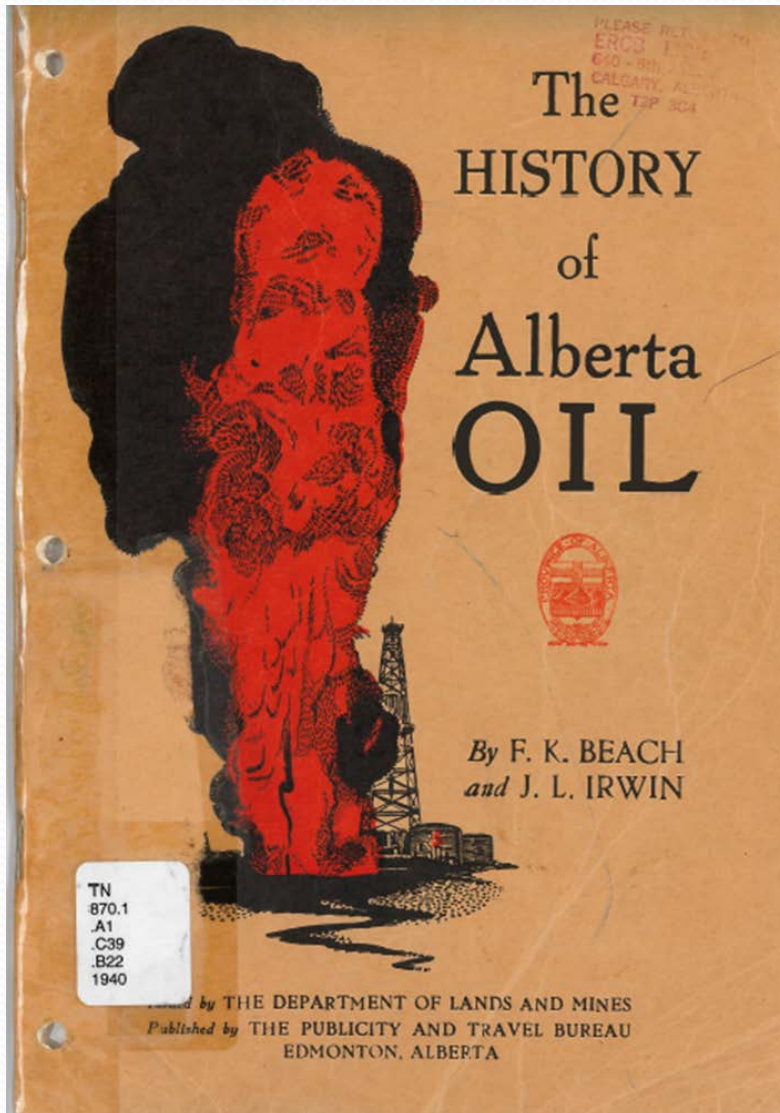
In the next two years the Alberta Geological Survey (AGS) will celebrate its 100<sup>th</sup> anniversary. Although the AGS officially has its birth year as 1920, survey work began earlier (in at least 1919) with geological field work that led up to the first AGS report on Mineral Resources of Alberta to the Government of Alberta. Other roots of the AGS go back to 1912, with the founding of the University of Alberta, and the appointment of Dr. John Allan, and head of the new Geology Department (later also founding head of the AGS). After this appointment, Allan was requested by the provincial government to assess and report on Alberta's natural resources. In Allan's first report to the Legislative Assembly, given in 1920, Dr. Allan reported on 18 different resources, including bitumen, natural gas, salt, coal, and other mineral resources. This was followed a year later by updates on salt spring deposits, bituminous sands, coal measures, iron deposits, petroleum oil and gas fields, salt wells, and other accessory resources, such as talc, mica and 'paint shale'. The first permanent staff geologist was hired in 1924, and since that time, staff numbers ranged from 0 in 1933-1942 (when it was shut down), to between 40 and 60 in the 2000s. The first geologic map of Alberta was published in 1926. Since the delivery of Allan's first two annual reports to the Alberta government, the AGS has systematically mapped and delineated the geology of the province and its resources, with approximately 1500 government reports and over 550 maps.

The AGS has been associated with different provincial-government agencies, since its founding; most notably, with the Alberta Research Council (and its forerunners) until 1995; and since then, mainly with the Alberta Energy Regulator (and its

predecessors). Although the role of the AGS may have changed over the years, it has consistently maintained an active presence in the delineation and understanding of the geology of Alberta's petroleum resources, including bitumen, oil, natural gas, coal-bed methane, and the emergent unconventional shale and siltstone liquids-rich gas and gas commodities. This presentation will emphasize the contributions that the AGS has made to the petroleum industry in its first 100 years -- giving a view to the past; and a glimpse to the future and Alberta's energy landscape changes over the next 100 years.

# History of the Alberta Geological Survey & Its Contribution to the Petroleum Industry in Canada

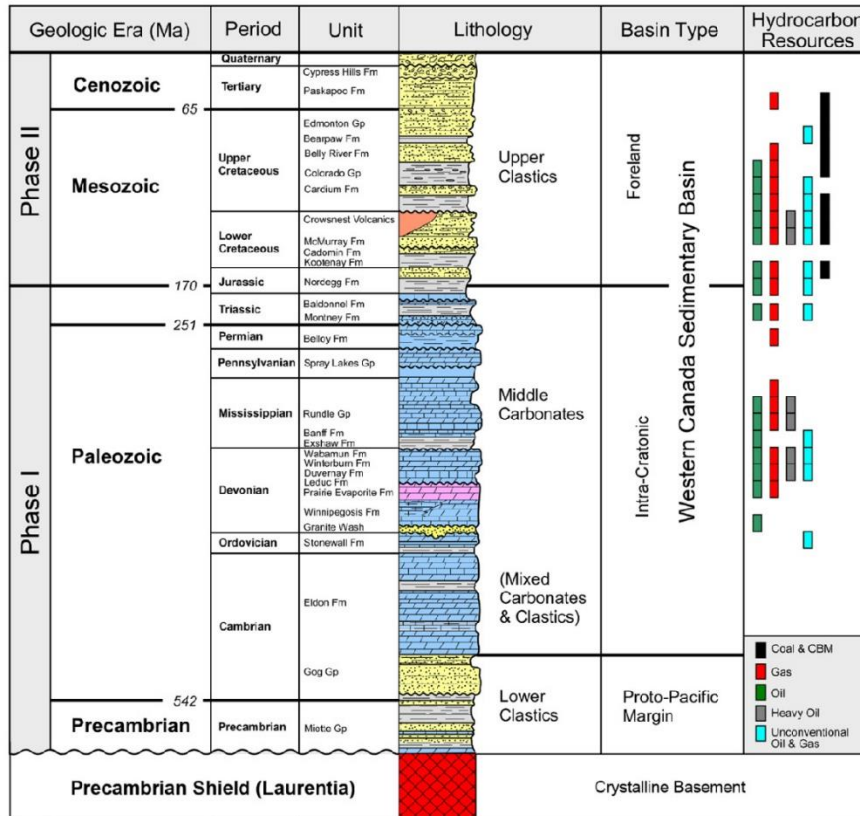
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Alberta Geological Survey (AGS)  
Alberta Energy Regulator (AER)



American Association of Petroleum Geologists  
Annual Convention & Exhibition (ACE)  
2019 San Antonio, TX

# Where are PNG, Bitumen, Heavy-Oil & Unconventional Oil & Gas Resources ?

Generalized stratigraphic column of Alberta



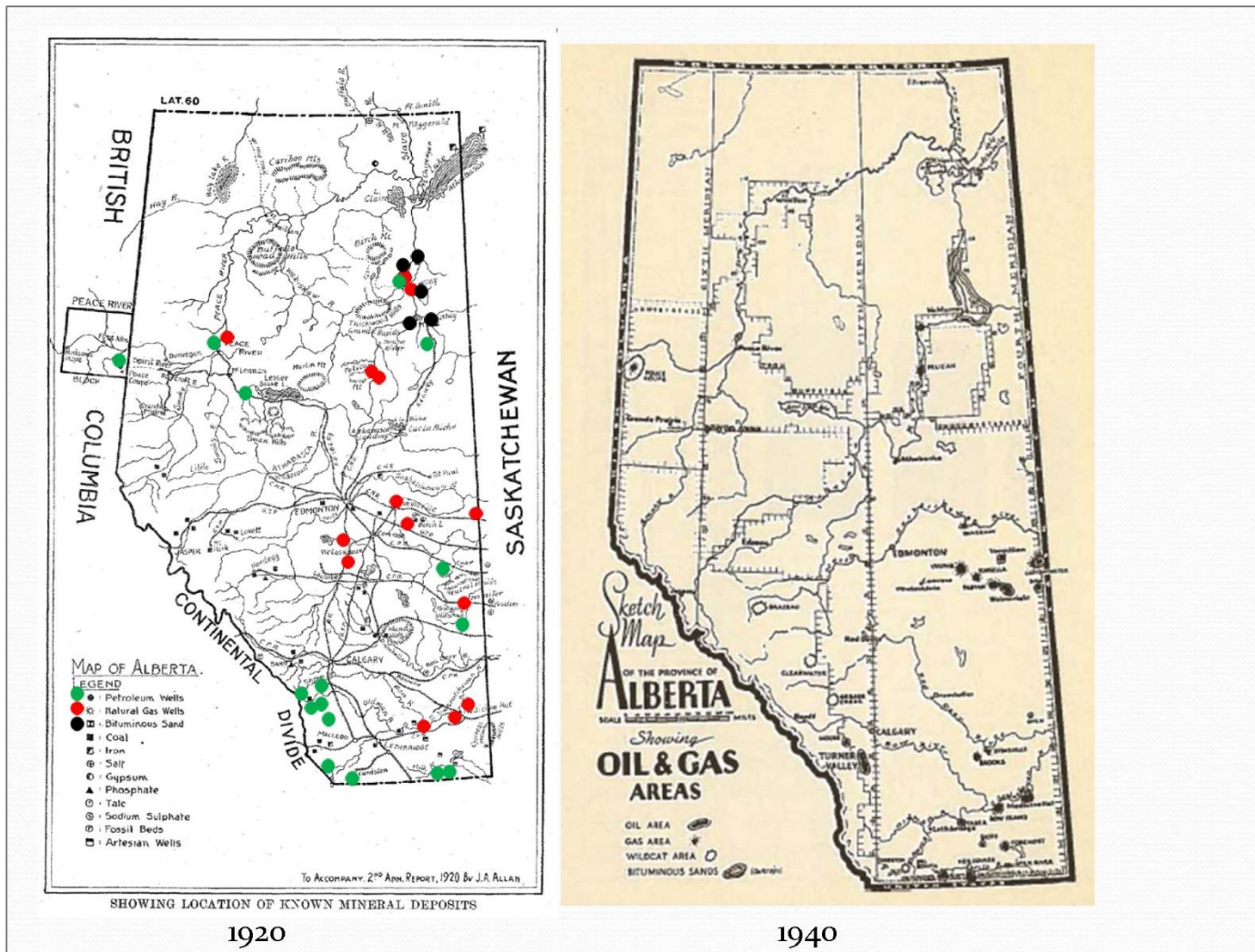
Petroleum

Natural Gas

Bitumen and Heavy Oil

Unconventional  
Shale & Siltstone  
Tight Gas,  
Liquids-Rich Gas,  
and Oil

Presenter's notes: First of all to get you situated, most of the petroleum, natural gas, bitumen, heavy oil and unconventional tight hydrocarbon resources are within Devonian and younger rocks of the Alberta Basin.



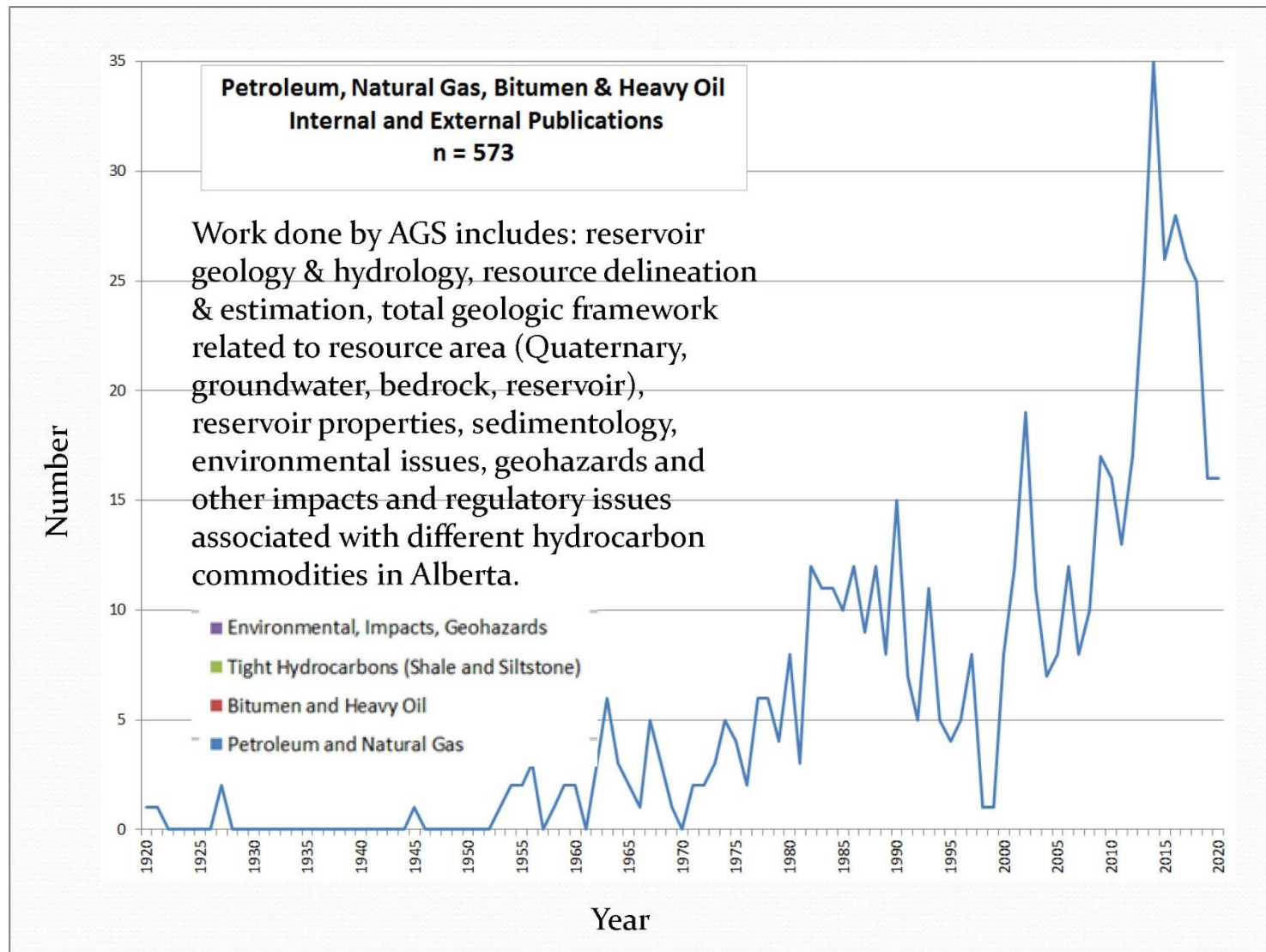
Presenter's notes: The First Resource Map, drawn by Dr. John A. Allan, in 1920 showed the then known oil, natural gas, and bituminous sand deposits in the Province. A map nearly 20 years, in 1940, showed a similar pattern, with a few additions and subtractions, about the same. This would all change 7 years later, in 1947, with the discovery of the Leduc #1 well, south of Edmonton, in the centre of Alberta.

**Leduc No. 1  
Discovery Well  
February 13, 1947**

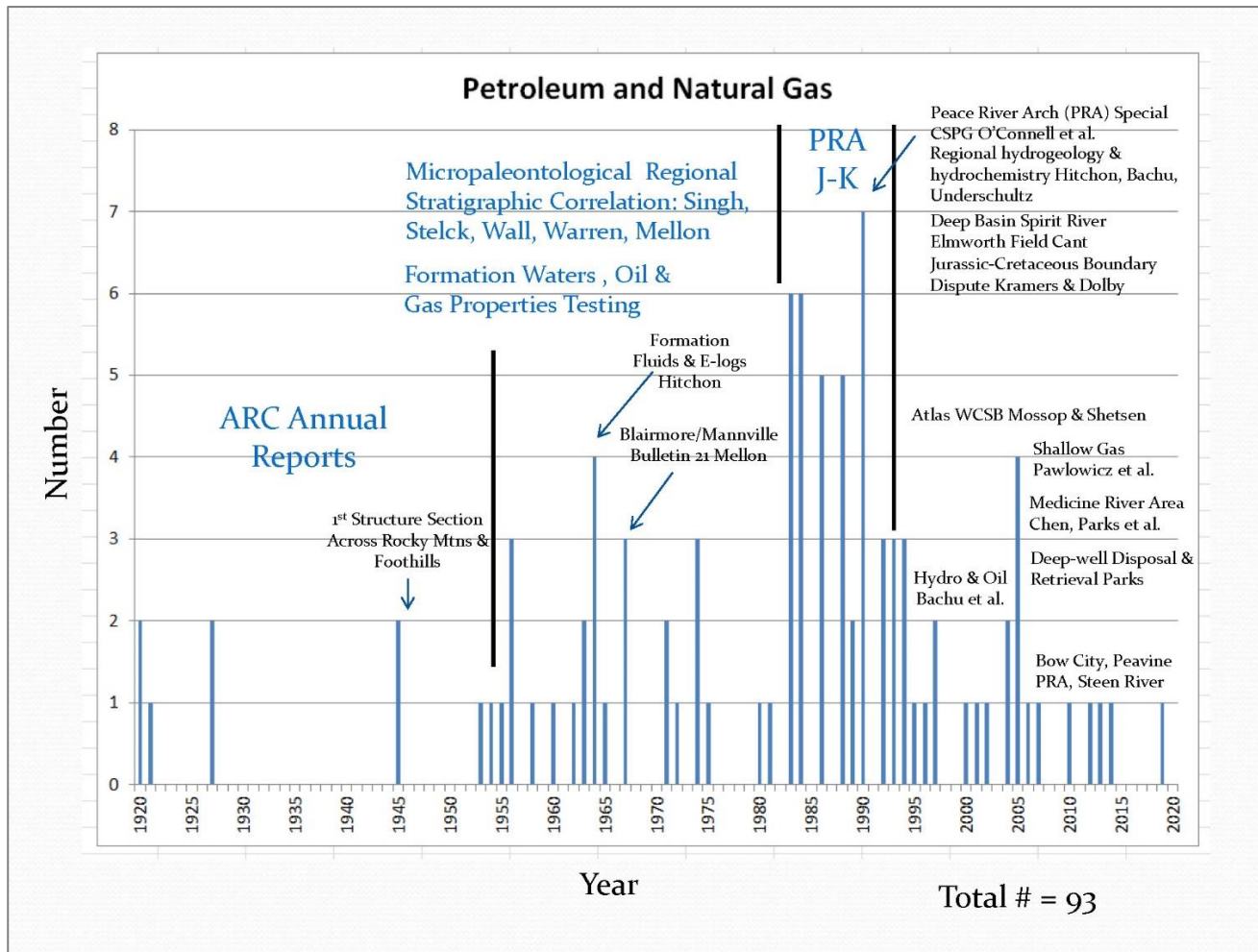


Glenbow Archives IP-6g-6

Presenter's notes: Discovery of Leduc #1, Feb. 13, 1947.

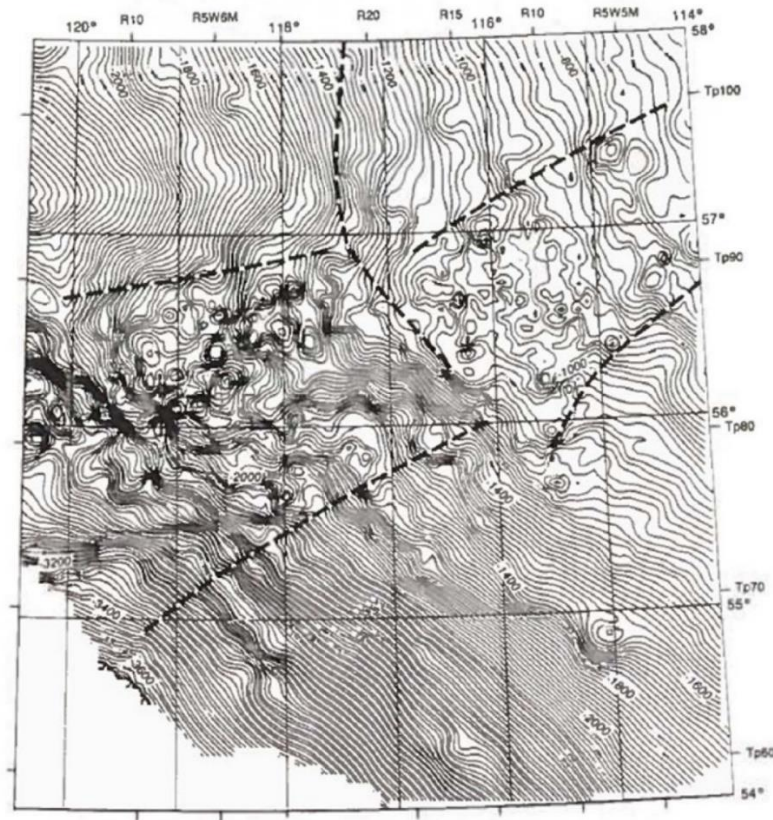
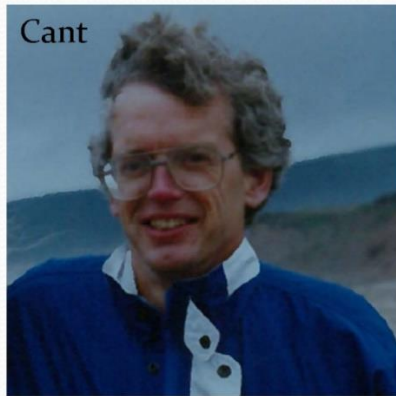
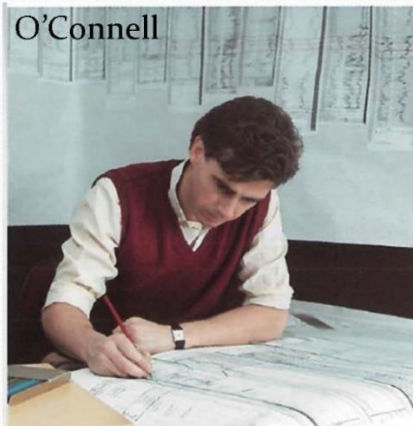


Presenter's notes: The AGS in its 100 years of work has published at least 573 reports, articles, talks and posters on the petroleum, natural gas, bitumen, heavy oil, and other unconventional hydrocarbons. This work also includes environmental issues, impacts and geohazards associated with the petroleum and oil sands industries in Alberta, but these will not be covered today.



Presenter's notes: To start off, all of the hydrocarbon resources (with the exception of the tight plays that are being explored today) were known and recognized as resources within Alberta from Day #1, in 1920, with the 1st Annual Report on the Mineral Resources of Alberta by Dr. John A. Allan, Founding Director of the AGS. In total there are about 100 publications (internal and external) that deal with Petroleum & Natural Gas. The first 35 yrs or so, these commodities were included in the Annual Reports of the Alberta Research Council, which housed the Alberta Geological Survey – at its founding a Division of the Council. Highlight main headings and changes through time as on the slide.



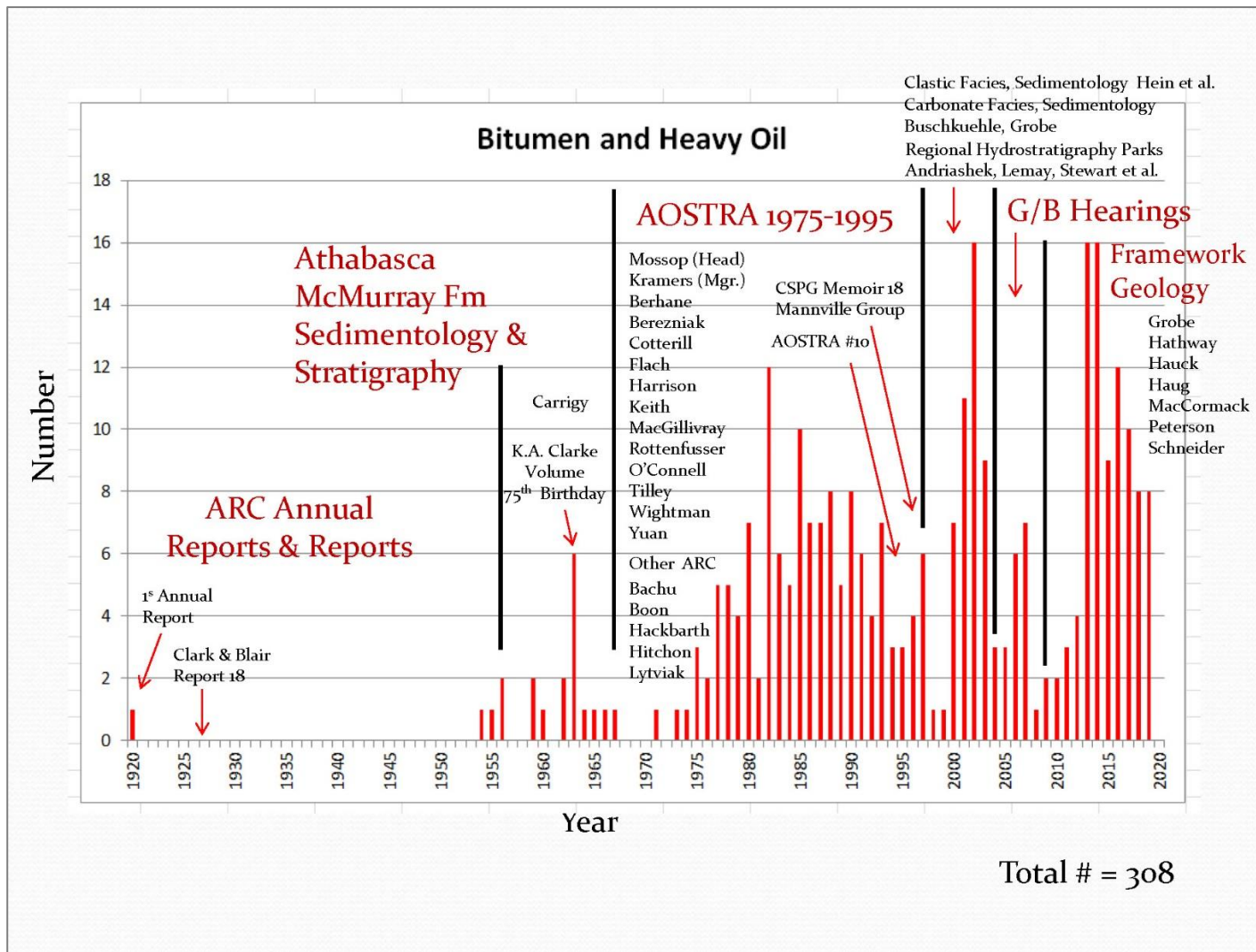


Structure-Contour Top Precambrian – Peace River Arch

Presenter's notes: The Hay Day of AGS work on Petroleum and Natural Gas extended from about 1980 to 1990, a decade during which the AGS and ARC did many geological and hydrogeological studies on the Peace River Arch and the Deep Basin area of western-central Alberta. Shown here is Sean O'Connell, who edited and compiled a dedicated issue of Bulletin of Canadian Petroleum Geology (by the CSPG) on the Peace River Arch; also Doug Cant, who single handedly was the Petroleum Geology Group at the Survey, largely funded through DOE. On the right is a Structure-Contour Map of the Arch, showing its delineation and major fault offsets.



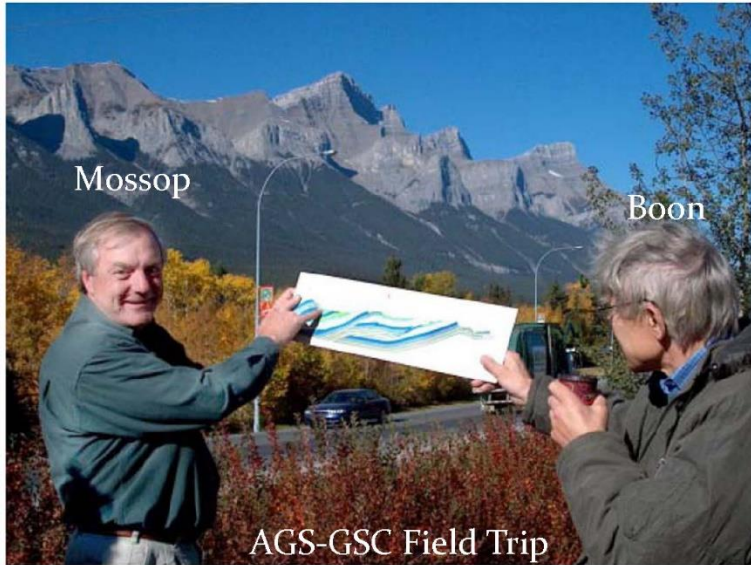
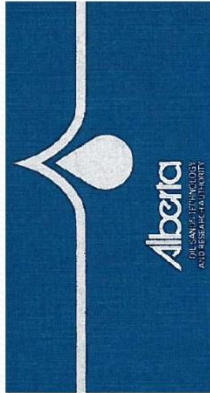
Presenter's notes: The other main production was the Geological Atlas of the Western Canada Sedimentary Basin, with some of the geologists named here, including Kramers, who later headed up the AOSTRA Oil Sands Section; Mark Fenton and John Pawlowicz, who did a lot of the Quaternary work; Jan Boon, who later was Head of the AGS; Stefan Bachu and Andres Lytviak, who worked in the Groundwater Division of ARC, later joined the AGS; Irina Shetsen who helped Grant Mossop compile the Atlas; and Rick Richardson, who also later became Head of AGS.



Presenter's notes: Perhaps the most geological work over the years on hydrocarbons relates to the oil sands of Alberta, with 308 publications (internal and external) done over the 100 year period. There were many more ARC-publications on oil sands, but these were done with Dr. Karl Clark, who was within the Bitumen Division of ARC and not the AGS – overall he published at least 75 articles and a significant number of patents on extraction of bitumen from the oil sands. (Presenter's notes continued on next slide.)

*(Presenter's notes continued from previous slide.)*

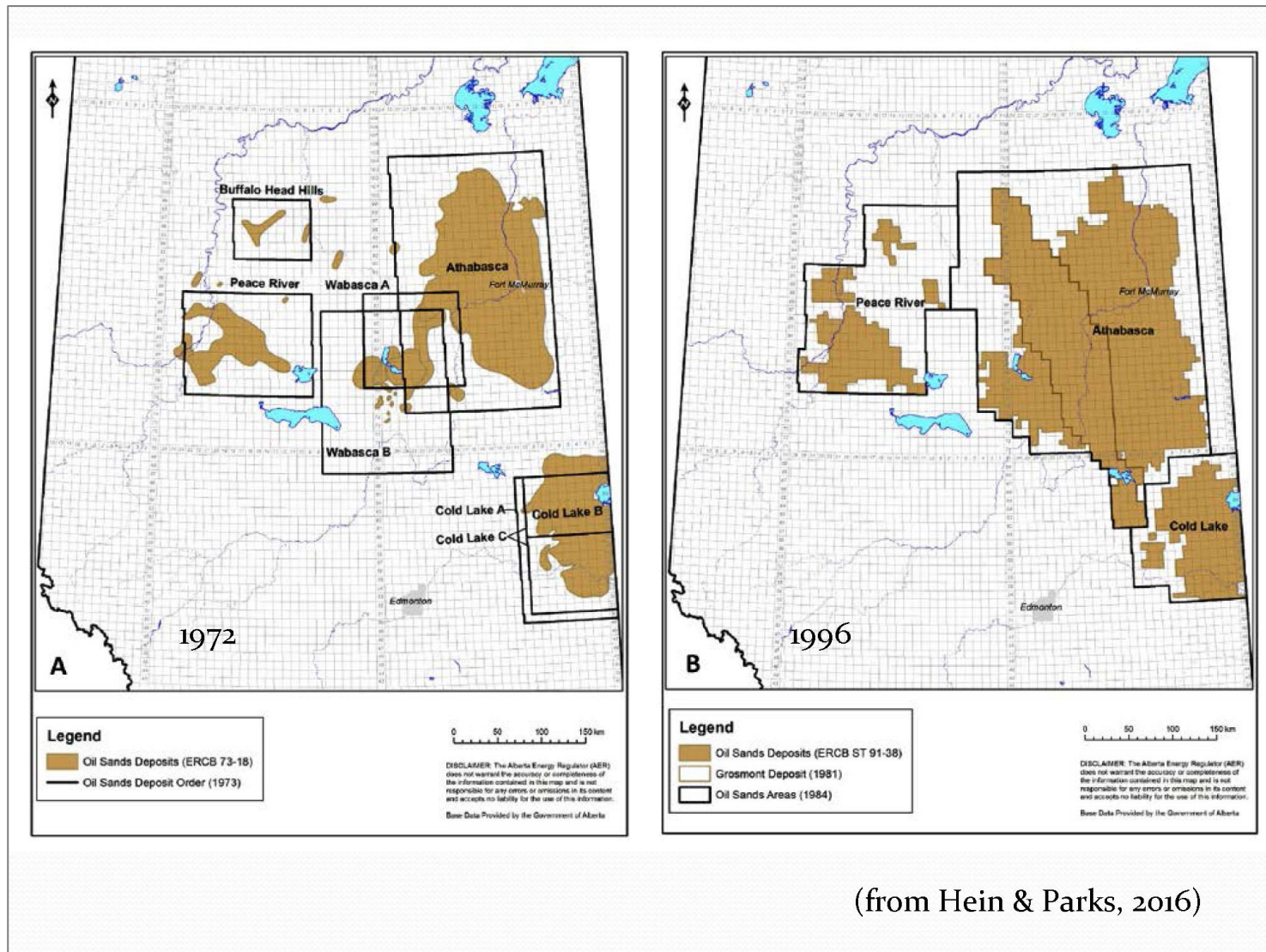
One more geologic-related report #18 is indicated here which was published in 1927 that dealt with the mineralogy and physical properties of the oil sands. Other than that the early work was mainly in ARC Annual Reports. The first real phase of oil sands work began in about 1955, with Carrigy, Mellon and others examining the McMurray Formation of the Athabasca oil sands from a stratigraphy and sedimentology perspective. In 1963, a major technical publication was given to Karl A. Clark on his 75th Birthday. The next major milestone was the Alberta Oil Sands and Technology Research Authority (AOSTRA) funding which existed for 18 years, and from which publications continued to be produced for 20 years. This nearly ½ million-dollar program at that time funded regional-scale geology studies of all the main oil sands and heavy-oil deposits in Alberta, much of which was never published externally. A new Section was created at the Survey, headed up by John Kramers, and at least 14 geologists at the AGS worked on this. The ARC also had complementary work on hydrogeological regime of the oil sands areas, with 5 or 6 from the Groundwater Division working on oil sands projects. AOSTRA # 10 Synthesis of Athabasca was published in 1995, with a lot of the work released externally in the CSPG Memoir 18 on the Mannville Group published in 1997. Starting in 1997, and continuing until about 2003, AGS work on the oil sands switched to a smaller-scale facies type of approach, looking at > 80 outcrops and 100s of subsurface cores of both the Cretaceous sandstones of the Athabasca and Cold Lake areas, and the carbonate bitumen underneath and outcropping around the Athabasca oil sands area. Regional hydrostratigraphy, based on groundwater studies were done in the Cold Lake and Athabasca areas, along with work on the shallow Quaternary and surficial deposits of the area. Starting in ~ 2003 the gas-over-bitumen hearings engulfed most of the geologists and hydrogeologists at the AGS, which was then part of the Energy and Utilities Board, and in the end after the initial submissions, inquiries and multiple hearings, it took about another decade to sort things out and get material published in the public domain. Since that time, starting in about 2010 or so, much of the work has related to the framework geology of the rocks, aquifers, and surficial sediments located “Above and Below the Oil Sands” – and the need to understand and characterize the entire geologic framework.



AOSTRA TECHNICAL PUBLICATION SERIES #10

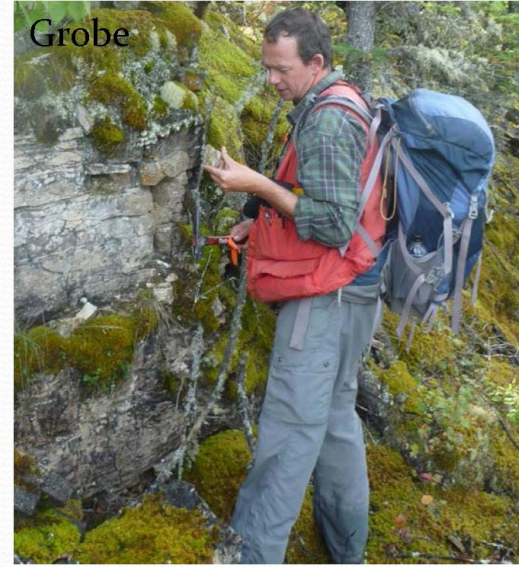
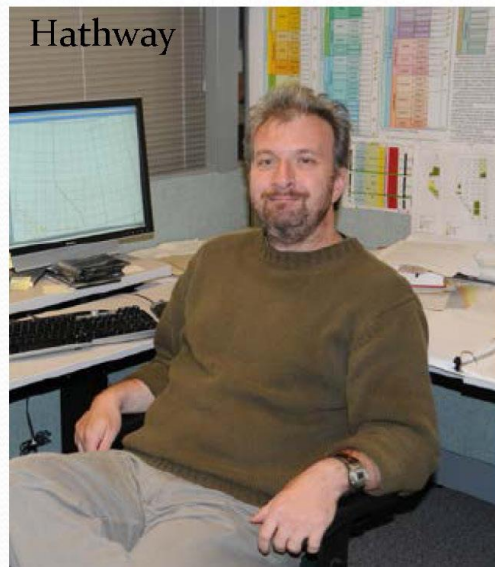
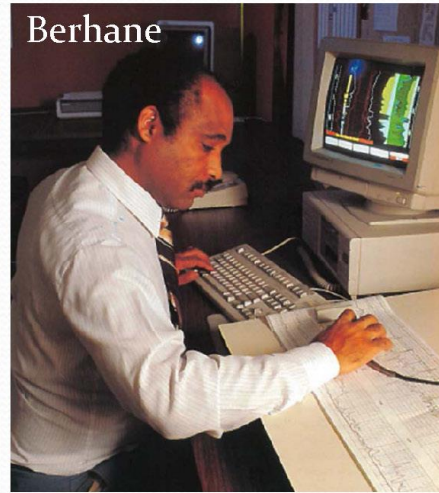
**Resource characterization of the  
McMurray/Wabiskaw Deposit in the  
Athabasca Oil Sands Area:  
A synthesis**

Presenter's notes: Some of the key players for the AOSTRA work at the Survey are shown here, starting with Maurice Carrigy and Barry Mellon, who along with Premier Getty, initiated and got in place the legislation and program for AOSTRA, which among other things produced the Big Blue Books. Shown on the left is Grant Mossop who was head of the Survey at the time, and was succeeded as Head by Jan Boon, when Mossop joined the Federal Survey in Canada.

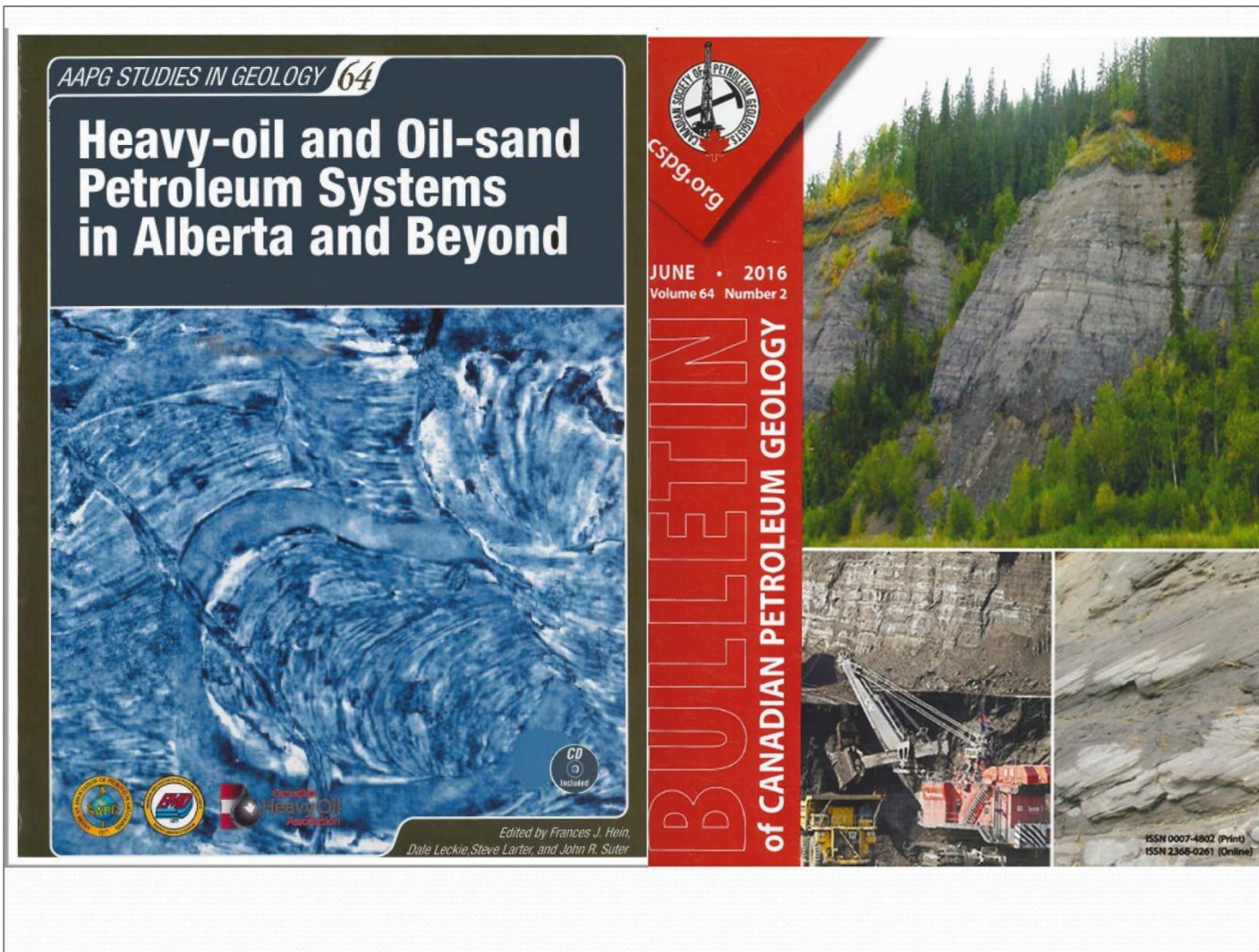


(from Hein & Parks, 2016)

Presenter's notes: These two maps show what was known about the oil sands distribution before AOSTRA in 1972 and after AOSTRA in 1996. For one thing, the deposits are more linked and more extensive, on a plan map, than first thought; and secondly their subsurface extents also increased substantially.

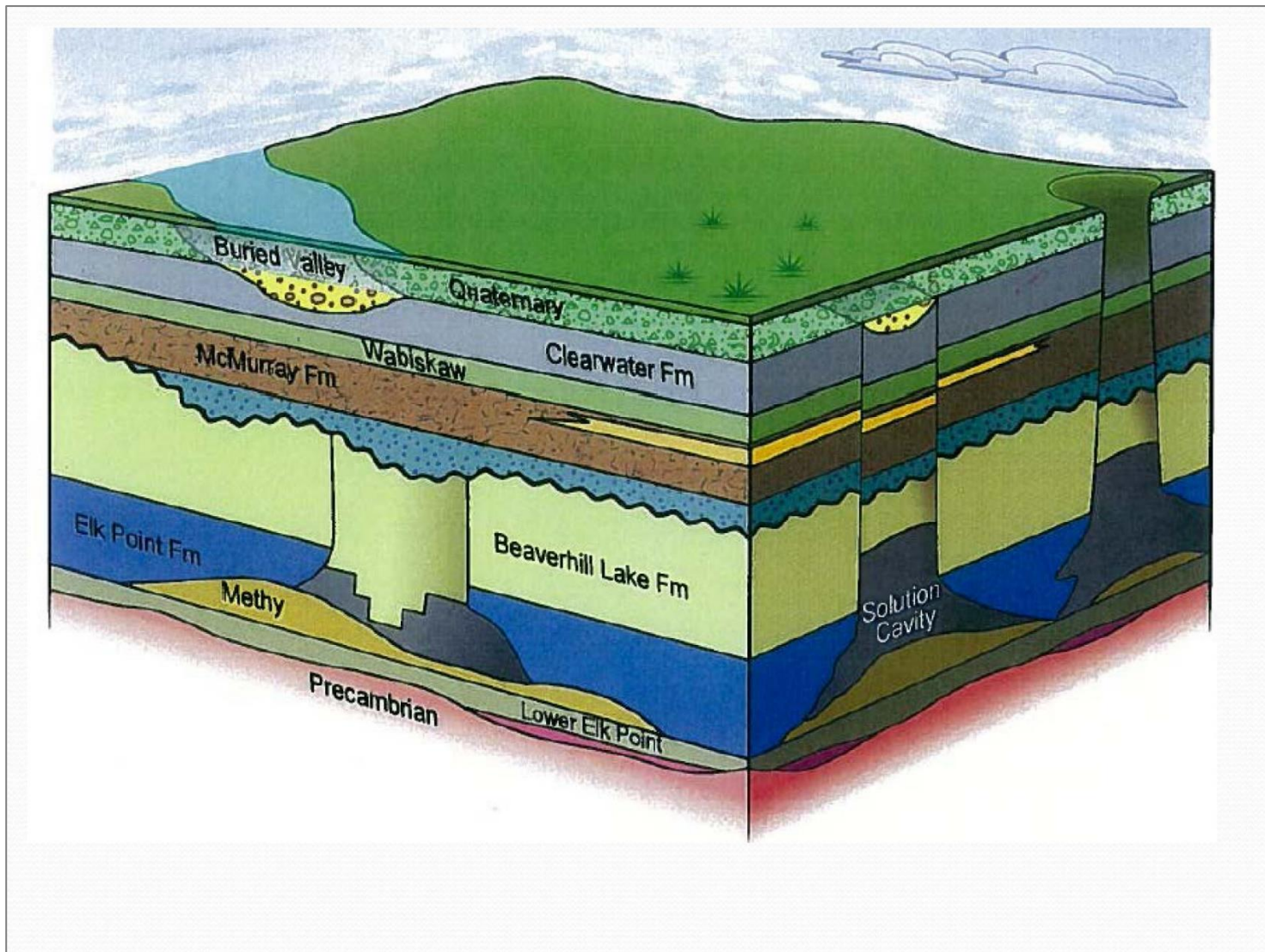


Presenter's notes: Some of the people that did the AOSTRA and later work on facies and the geological framework are shown here. Mention names, etc.



Presenter's notes: A couple of notable external publications came out on the oil sands, the first was one that I co-edited for the AAPG, which was the AAPG Studies in Geology 64; and the second was a Multidisciplinary Symposium that came out as a dedicated Bulletin of Canadian Petroleum Geology (CSPG), which I co-chaired and organized with Chris Seibel (formerly of Nexen in Calgary) and Kevin Parks, a hydrogeologist at the Alberta Energy Regulator.





Presenter's notes: Part of what came out of these geological studies, and subsequent investigations associated with the Board, was the need to understand the Total Geological Framework within which the oil sands are enclosed – that is the under-burden, over-burden and any associated bedrock aquifers. Much of the work after the G/B hearings (*Presenter's notes continued on next slide.*)

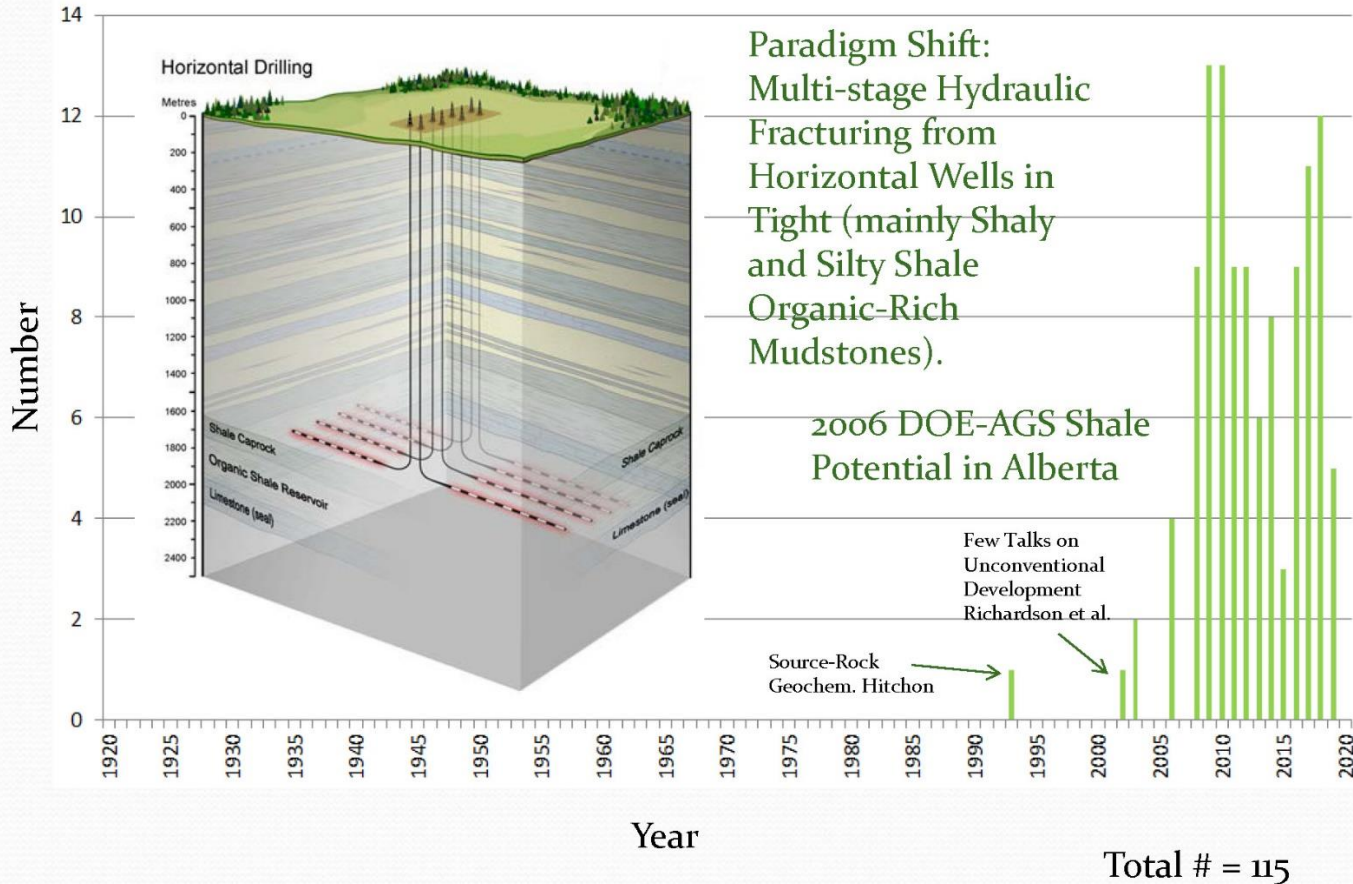
*(Presenter's notes continued from previous slide.)*

was involved with identifying areas of solution within the underlying carbonates and evaporites, the identification of cap rocks and their integrity; and possible geohazards or risks associated with in-situ steaming of underground bitumen reservoirs – including contamination of aquifers, fracturing of cap rocks, release of toxins to groundwater, surface water, and the air; and effects on the ground, including heaving and subsidence. These environmental aspects are quite varied and interconnected, and are beyond the scope of this talk; but are a very important part of the AGS work in all areas of energy development in the Province.



Presenter's notes: Some of the work involved regional hydrogeological studies of Cold Lake and Athabasca areas; mapping of Quaternary outcrops and auger coring; and as you can see the layers are sometimes deformed, associated with glacial-thrusting in the oil sands areas, which may affect caprock integrity and reservoir continuity in the subsurface.

## Tight Hydrocarbons (Mainly Shale and Siltstone)



Presenter's notes: As we all know there was a huge paradigm shift to tight hydrocarbon development associated with applying the technologies of multi-stage hydraulic fracturing with horizontal drilling. This is true throughout North America, but really only came on the radar to the Alberta Government in 2005/2006. Prior to that the only AGS/ARC (*Presenter's notes continued on next slide.*)

*(Presenter's notes continued from previous slide.)*

work related to shales regarded source-rock geochemistry. Starting in the early 2000s, Rick Richardson, then Head of the AGS, gave a number of talks with others, on the potential and changes associated with the development of other unconventional tight (mainly shale and siltstone) hydrocarbon reservoirs. In 2006, the Department of Energy (DOE) funded a regional AGS study to examine and document the Shale-Gas Potential of Alberta – including gas, liquids-rich gas, and oil; but excluding Coal Bed Methane (CBM), which had previously been done with the AGS Coal Program.



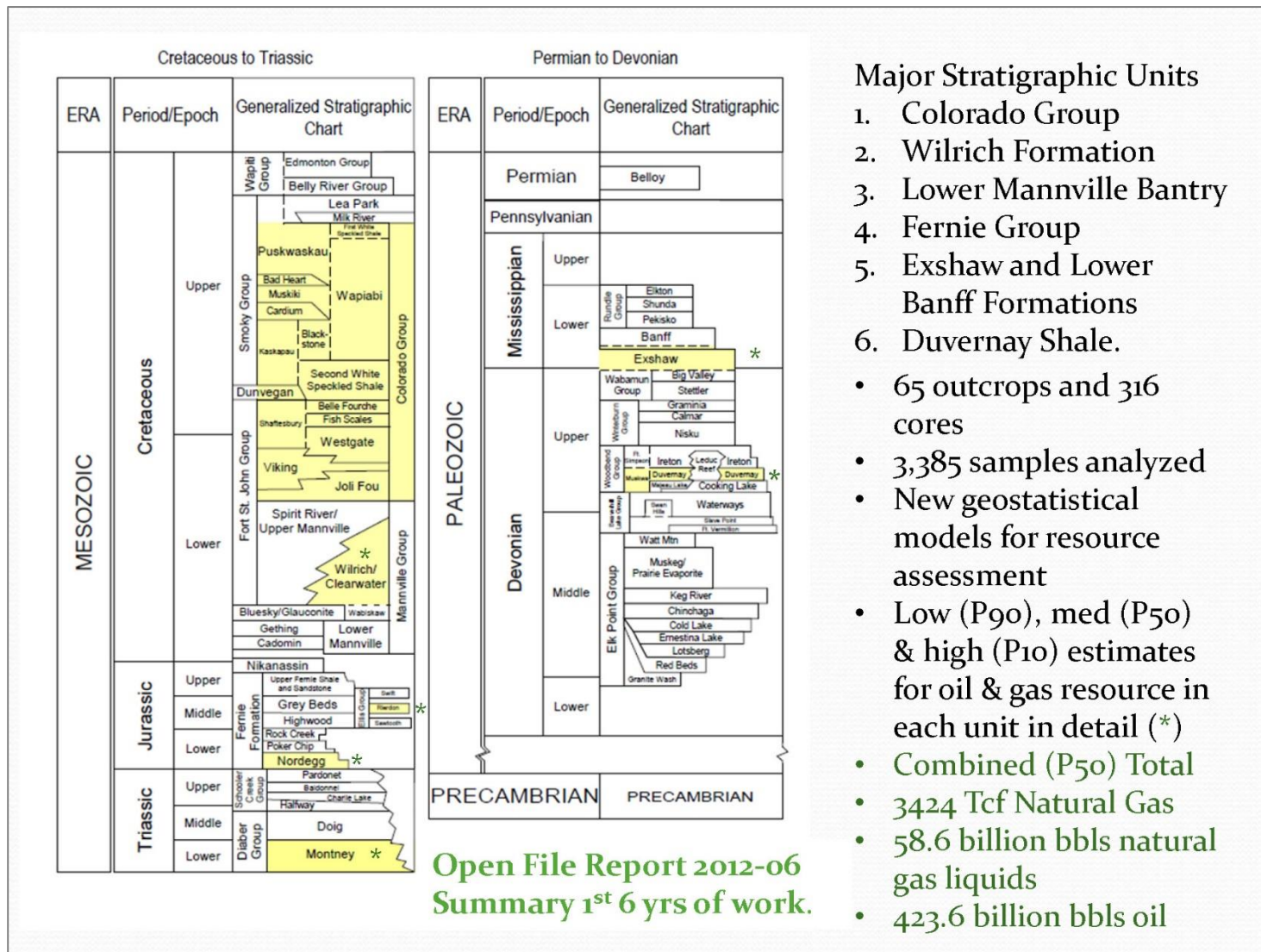
Exshaw Type & Lower Banff Section, Jura Creek, near Canmore, West of Calgary

Presenter's notes: The AGS embarked on a 6-year + study that looked at outcrops and available cores, with sampling and logging at a scale down to 1 m. One of the good prospects was the Exshaw and Lower Banff Shale shown at the Exshaw type section at Jura Creek, near Canmore – which had previously some work done, and was resampled and logged in detail.



Colorado Group Shales (Joli Fou to Fish Scales Fms.), Birch Mtns, NE Alberta

Presenter's notes: Other shales included ones that had previously never before been assessed, such as the Colorado Group Shales in the Birch Mountains of northeastern Alberta.



Presenter's notes: In 2012 an Open File Report summarized the first 6 years work, of course there were a lot of interim reports, talks, and other publications. By this time 65 outcrops and 316 cores were logged and sampled, with 3,385 samples analyzed for everything from RockEval, TOC, mineralogy, petrography, etc. New geostatistical models (*Presenter's notes continued on next slide.*)



*(Presenter's notes continued from previous slide.)*

were developed for shale/siltstone-gas and oil resource assessment for low (P190), medium (P50) and high (P10) estimates. In total for the combined Exshaw, Duvernay, Montney, Nordegg, Wilrich and Rierdon, it was estimated that the combined (P50) total was 3,424 Tcf Natural Gas; 58.6 billion barrels of natural gas liquids; and 423.6 billion barrels of oil were hosted in unconventional shales and siltstones in Alberta. Over 20 talks were given to all levels of government, from local municipalities to the Treasury Board and Finance, as well as at the AAPG ICE, ACE, CSPG, and other technical conventions.



Rokosh

Pawlowicz



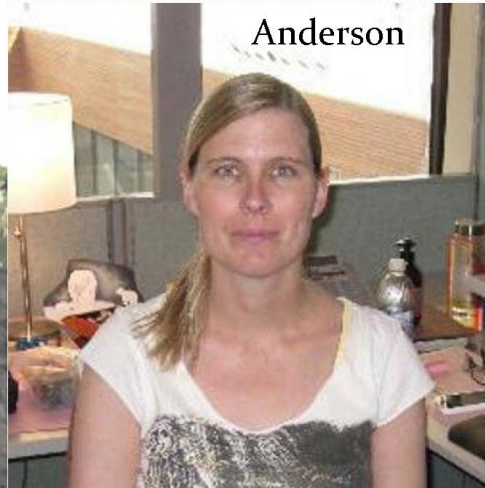
Lyster



Berhane



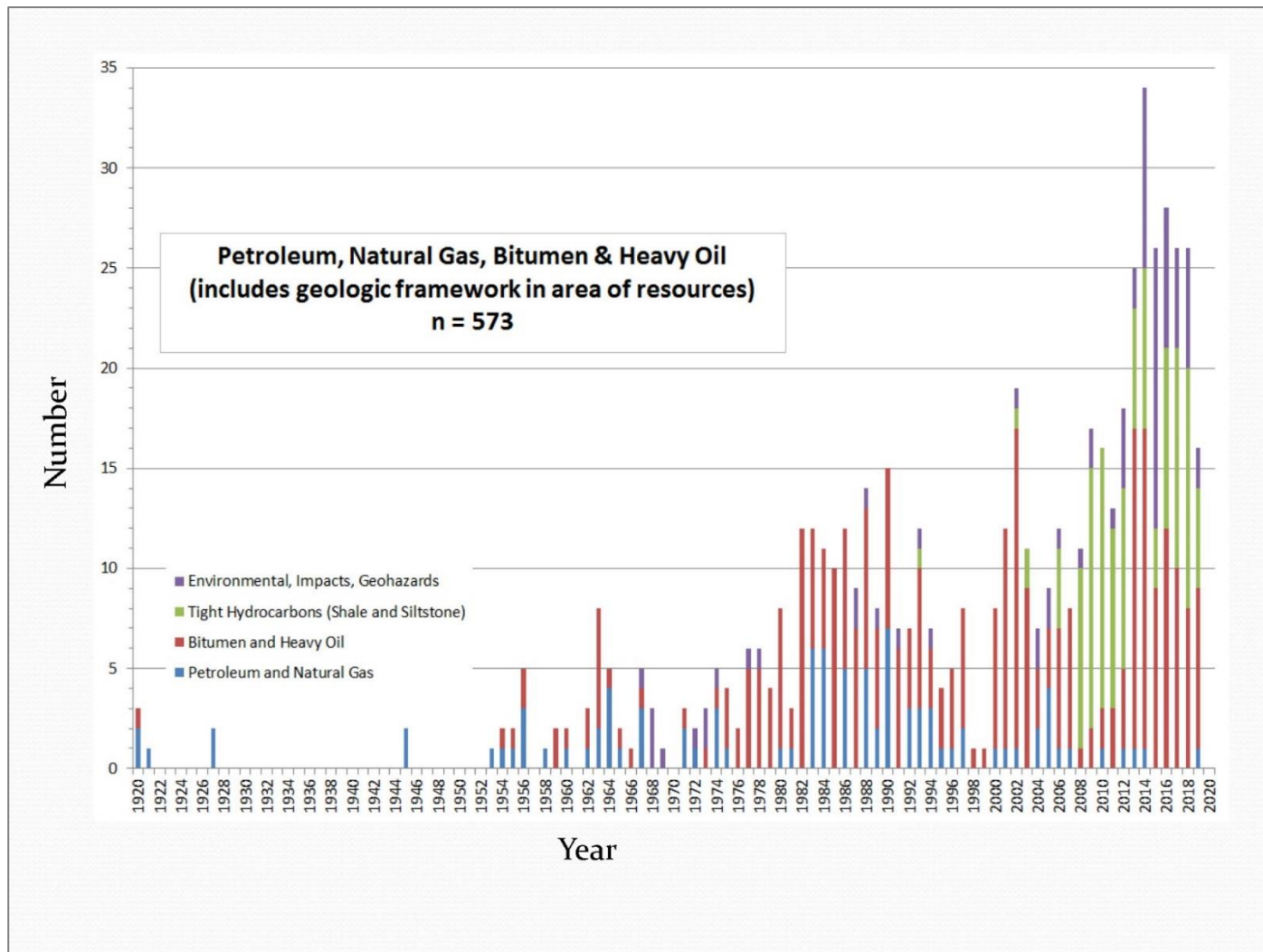
Beaton



Anderson

Some of the  
AGS Shale-Gas  
Team

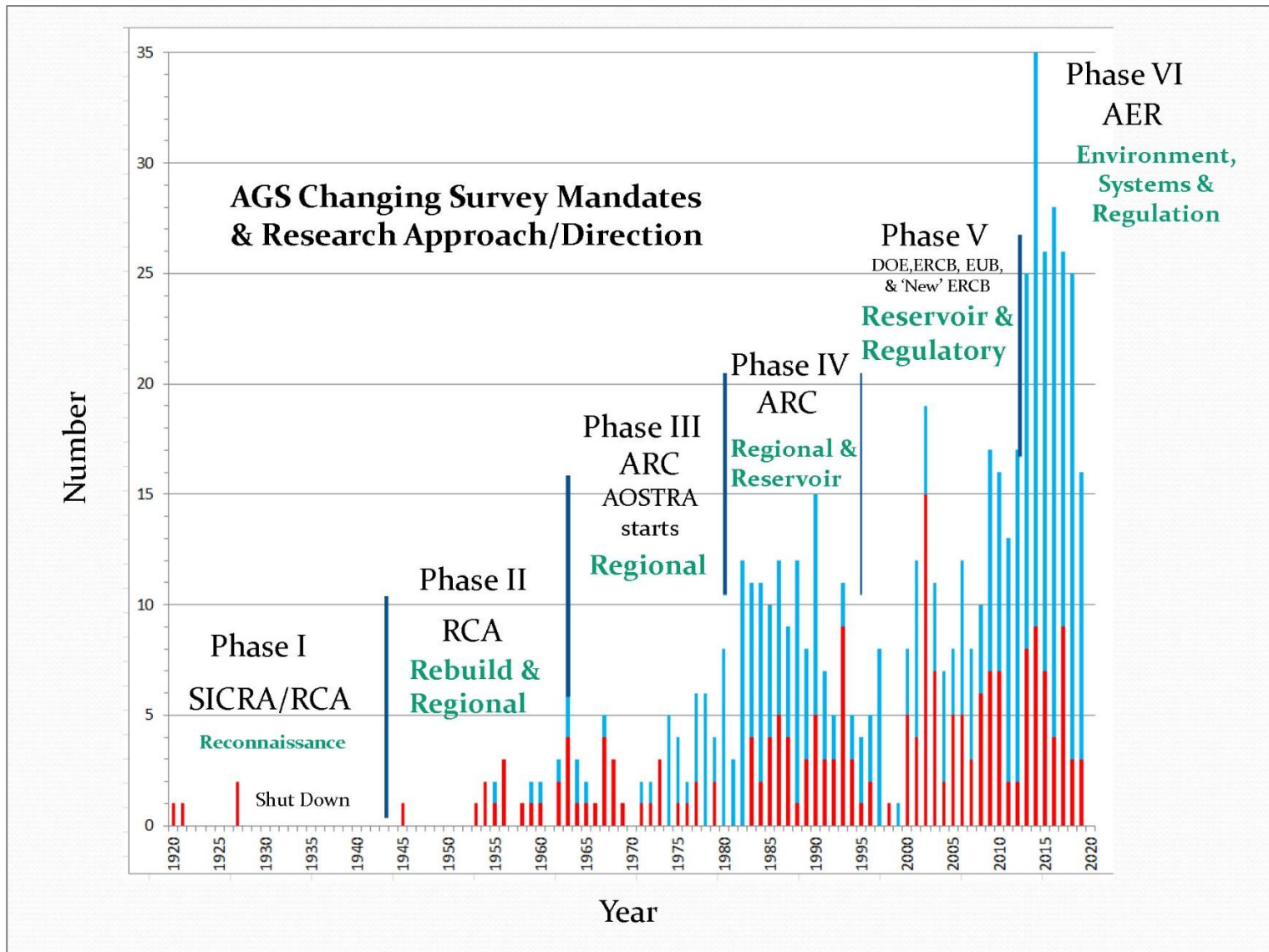
Presenter's notes: These are the main players in the AGS Shale-Gas Team: Beaton (My coauthor and Head of AGS), Shar Anderson (on the bottom, now a manager at AGS); and on the top Dean Rokosh, John Pawlowicz (now retired); Steve Lyster; and Mike Berhane.



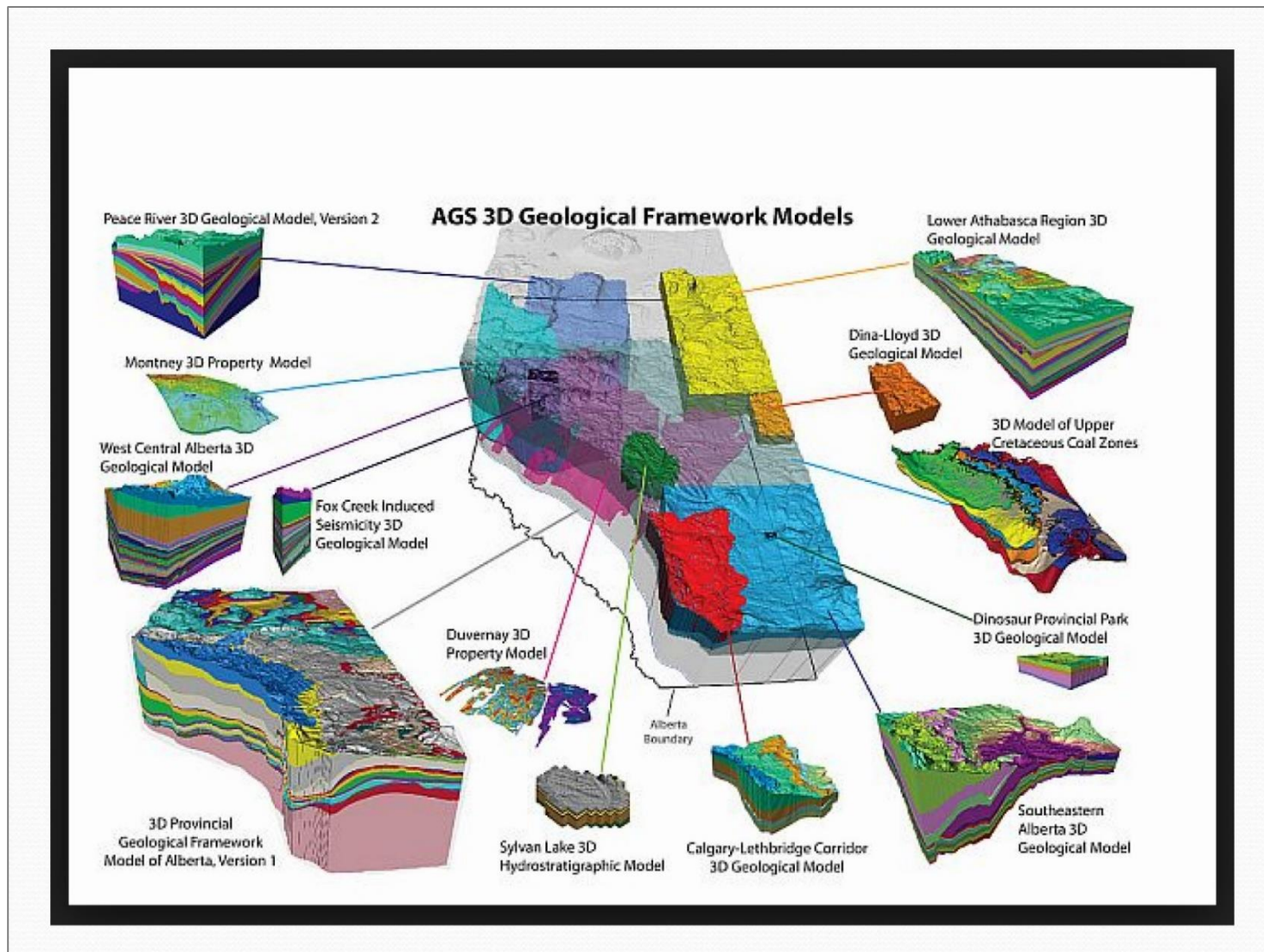
Presenter's notes: This graph shows the sum total of all the compiled AGS work on Petroleum, Natural Gas, Bitumen and Heavy Oil for the last 100 years. In Blue is Petroleum and Natural Gas; in Red Bitumen and Heavy Oil; in Green Tight Hydrocarbons (Mainly Shale and Siltstone); and I have also plotted Environmental Studies related to (*Presenter's notes continued on next slide.*)

*(Presenter's notes continued from previous slide.)*

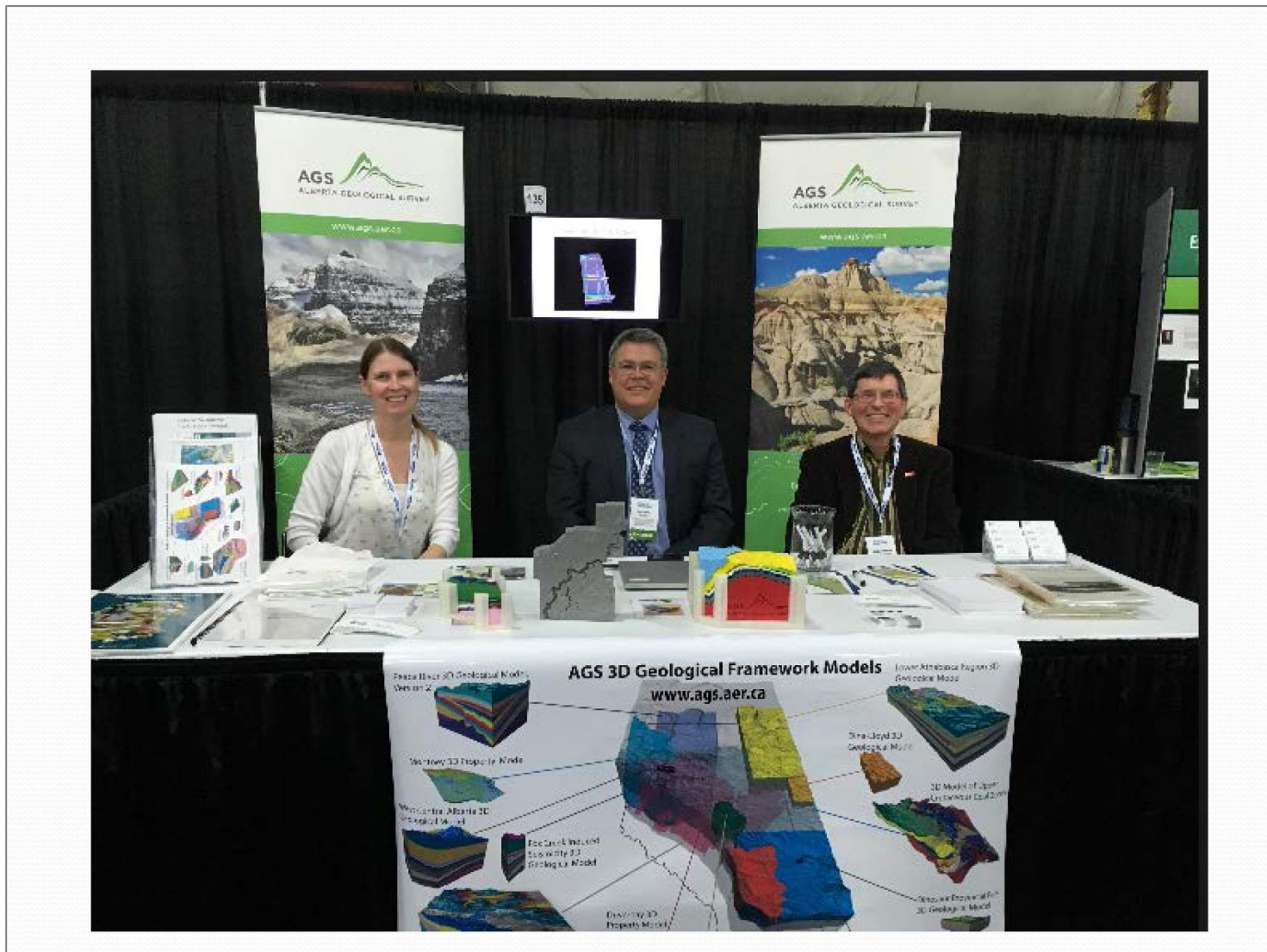
the oil sands and oil-gas industries in Alberta. As you can see, the AGS work Blue PNG peaked around 1980-1986, with a few continuing on; Red Bitumen and Heavy Oil is multimodal, reflecting the different drivers discussed already; the Green Shale and Siltstone Work commenced in 2005/2006 and Rose quite quickly, surpassing the PNG numbers in less than a decade; and although environmentally-related issues have been ongoing since the mid 1960s, there is certainly increased work in this regard, as a response to increased awareness and due diligence and environmental stewardship regarding oil, gas and oil sands development in Alberta.



Presenter's notes: This just shows the same plot, but with internal government in red and external publications in blue, and showing the changing mandate and location of the AGS in the Government through time.



Presenter's notes: This is where we are today – building 3D Geological Frame Work Models in Alberta, and related to a variety of different geological, hydrogeological and environmental aspects associated with resource occurrence and development in the Province.



Presenter's notes: And this is where the AGS is heading; and on behalf of my coauthor (Andrew) in the Centre, along with Shar Anderson (who coordinated and led a lot of the Unconventional Hydrocarbon work); and Laurence Andriashek (Quaternary Geologist, and the old-timer with the most number of yrs at the AGS) we want to thank you for your attention. And on to the Next Centennial!



# Extra Slides



# Alberta Geological Survey (AGS) Centennial Project (1920-2020)

## Sources of Information

- All AGS website postings  
<https://ags.aer.ca/>
- All available Alberta Research Council and AGS Annual Reports, Internal Gov't Reports; Ops Plans.
- Provincial Geologists' Journal;
- External Publications (mainly AAPG (including EMD website postings); Bulletin of Canadian Petroleum Geology, CSPG Memoirs, SEPM Special Publications; AAPG/GAC-MAC/CSPG/GeoConvention, CHOA; Remote Sensing, Rock Mechanics, and Hydrological Conference and Other Presentations;
- CVs of Staff as solicited or publically available.



John Allan and Ralph Rutherford doing fieldwork (photo from the University of Alberta archives).

1924 Dr. Ralph Rutherford joins the Geology Division of SIRCA as a full-time geologist after working as a temporary field geologist in 1917 with Dr. Allan. The two are now responsible for surveying the entire province of Alberta.

FIRST ANNUAL REPORT  
ON  
THE  
MINERAL RESOURCES  
OF ALBERTA

BY  
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PROFESSOR OF GEOLOGY  
UNIVERSITY OF ALBERTA

PRINTED BY ORDER OF THE LEGISLATIVE ASSEMBLY



EDMONTON  
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1920

Birth Year generally taken as 1920, the year that the first report on the Mineral Resources of Alberta was given by Dr. John Allan, founding Director of the Geological Survey Division of the Scientific and Industrial Research Council of Alberta (SIRCA, later ARC, housed the AGS until 1995).

SIRCA Broad Mandate to:

“Engage in and supervise research to the determination and development of the province’s mineral and energy resources.”

# Environmental, Impacts, and Geohazards

