geoconvention
Calgary • Canada • May 11-13 2026

Exploring for Oil and Gas in Precambrian-Age Fractured and Weathered Crystalline Basement Reservoirs in the USA and Canada – a Geologically High Risk but Potentially High Reward Hydrocarbon Play

Tako Koning, P.Geol., Senior Geologist
Independent Calgary-based Consultant

INTRODUCTION

This presentation is focused on the potential for significant resources of oil and gas in crystalline basement in the USA and Canada. Only minor amounts of oil and gas have been produced to date in the USA, as detailed below. Rather surprisingly, although the Western Canada Sedimentary Basin is one of the most prolific sedimentary basins in the world producing over 4 million barrels of oil per day, no oil or gas has ever been produced from basement in the basin. In my view this is because there has never been a deliberate basement-focused oil or gas exploration program in the basin.

Major volumes of oil and gas are produced from reservoirs in fractured and weathered basement in China, Vietnam, Indonesia, India, Libya, Venezuela and Russia. The volumes of oil and gas produced from the basement fields worldwide vary from barely economic volumes to giant-size fields. For example, oil is produced from Jurassic schists in California with some of the basement-reservoired oil pools having reserves as little as only 2 million barrels of oil. On the other end of the scale are basement fields like Auguila - Naafora in Libya with estimated reserves of 1.8 billion barrels of oil in basement. The Bach Ho-White Tiger oil field, offshore Vietnam has approximately 1.4 billion barrels of oil produced from basement. Other “high-end” examples include the Suban gas field in South Sumatra which has reserves of over 5 TCF gas. Suban is in an area where 8 gas fields were found in basement with gas reserves totaling 15 TCF. The Renqiu oil field onshore China has reserves of approximately 2.3 billion barrels of oil and is the world’s largest oil field in basement.

The basement lithologies of some of these fields includes fractured Precambrian granite in Libya’s Auguila-Naafora oil field. in Vietnam’s Bach Ho field oil production is from fractured Precambrian granites. The gas production from the Suban field in South Sumatra is from fractured pre-Tertiary age granites. Oil production from China’s Renqiu field is from Cambrian and Ordovician basement dolomitic carbonates located in a “buried hill” type of structural closure.

Production from these fields is mainly from natural fractures in the basement. These are the result of regional or local tectonism. The La Paz field in Venezuela which has produced over 300 million barrels of oil from Precambrian basement. Fractures in the basement of La Paz are associated with a prominent reverse fault. The Auguila-Naafora oil field in Libya has fracturing associated with normal faulting. The Suban field is the result of regional wrench (strike-slip) faulting. With

some basement oil and gas fields like Auguila-Naafora and Suban, weathering at the top of basement has also created excellent basement reservoirs.

USA: Production of Oil and Gas from Basement

Orth Oil Pool, Kansas: Minor volumes of oil have been produced from the Orth field, central Kansas. Approximately 1 million barrels of oil have been produced from basement from 15 wells. The reservoir in Orth is Precambrian fractured quartzites. The source rocks are adjacent and overlying Pennsylvanian-age shales. Oil is produced from the top of Precambrian buried hills, at a depth of about 1,000 meters (3,300 feet).

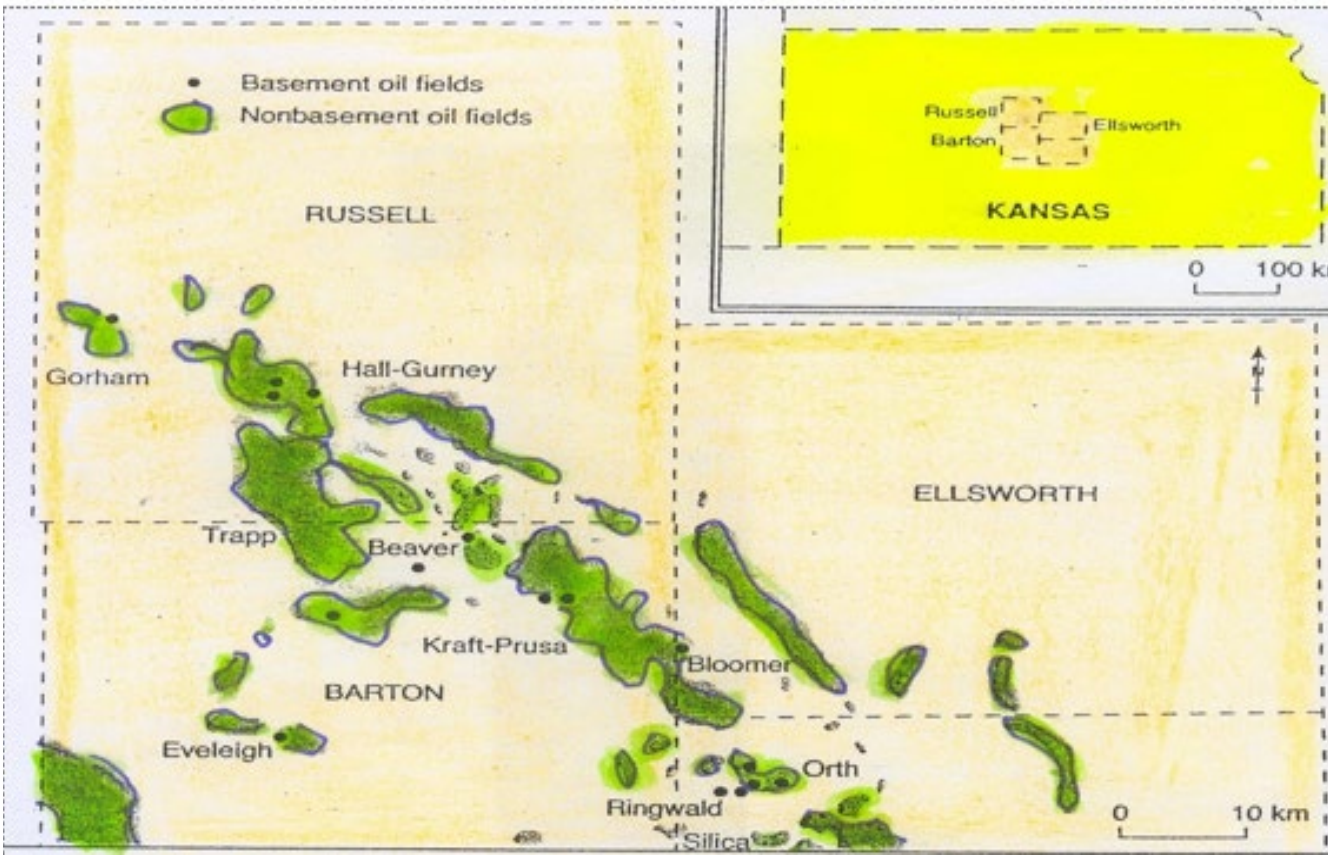
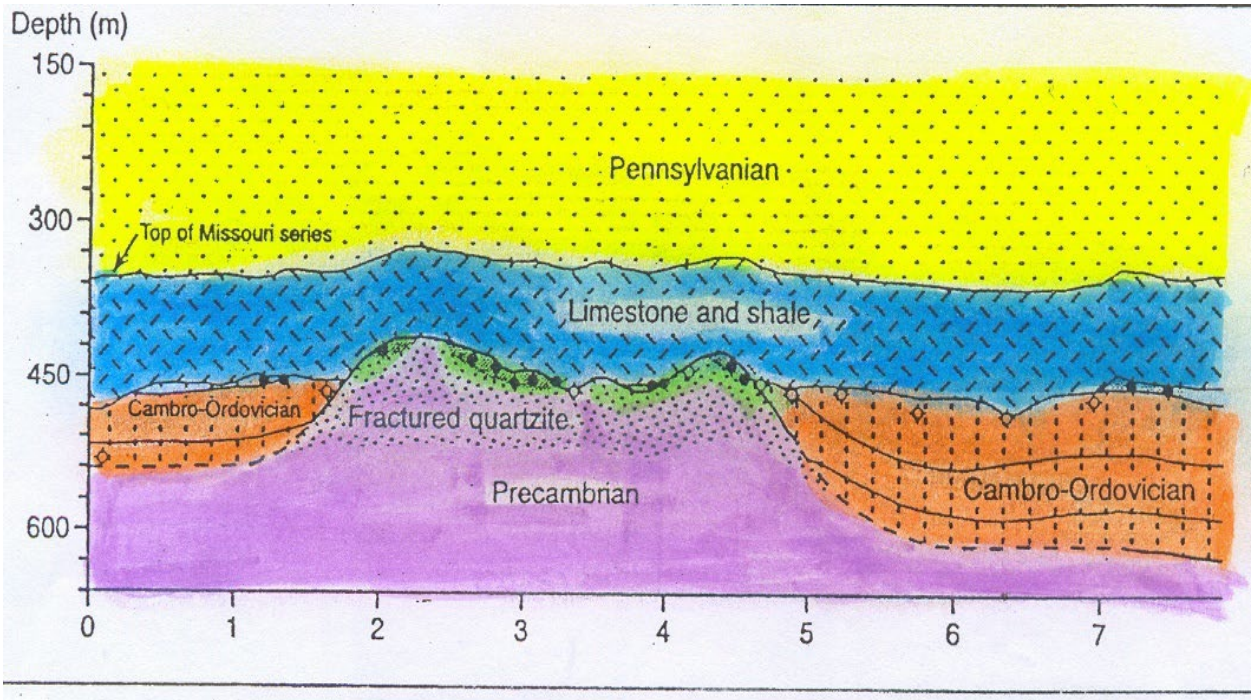


Figure 1. Kansas, USA – Fractured Precambrian quartzite buried hill oil pools. From: K.K. Landes et al., 1960, Petroleum Resources in Basement Rocks, AAPG Bulletin, Vol.40, No. 10 (October 1960), PP 1682-1691.



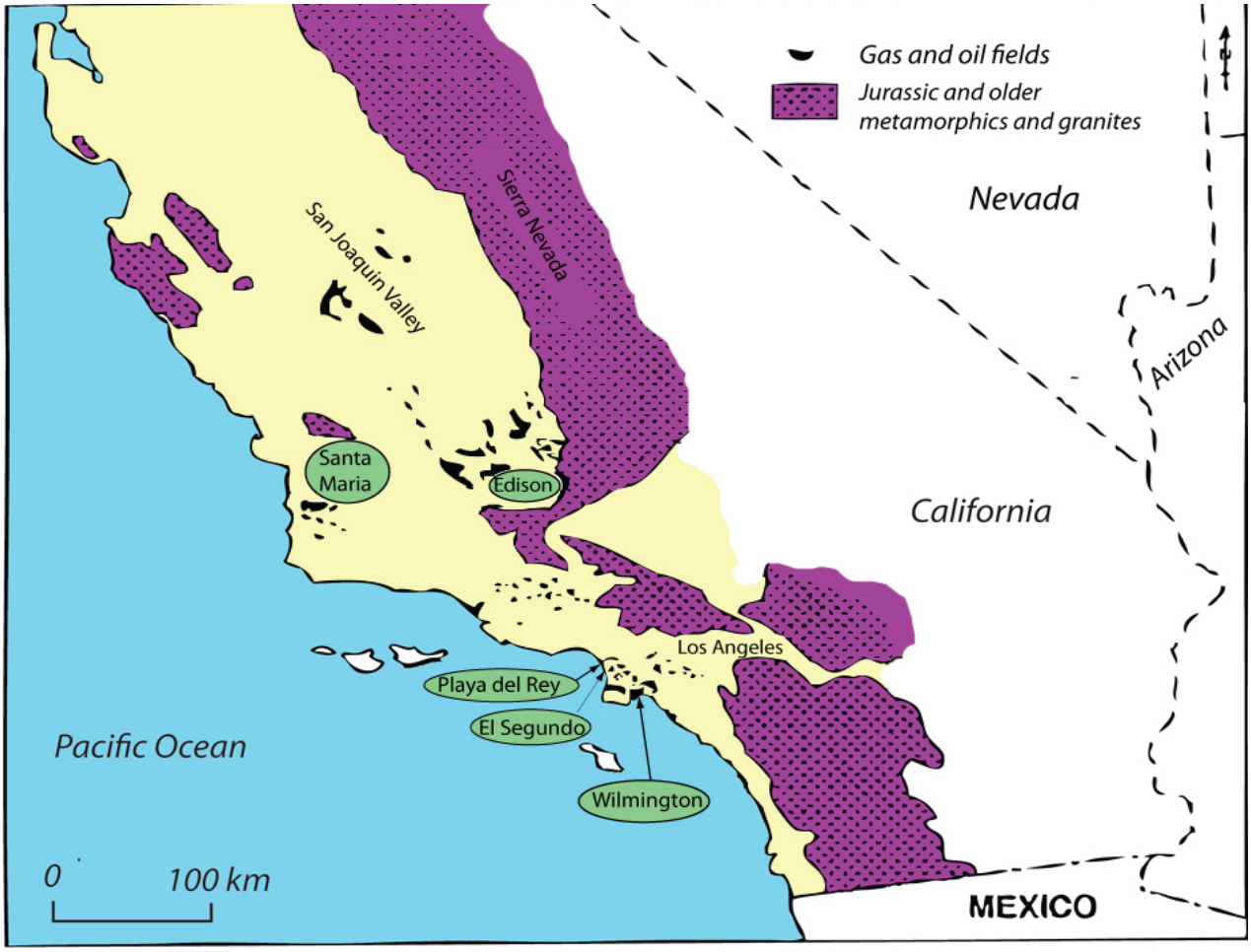
Kansas basement oil production. Oil is produced from Precambrian basement (in section), most ommonly fractured quartzites. Oil is sourced from flanking Cambro-Ordovician or overlying Pennsylvanian cks. (Landes *et al*, 1960).

Figure 2. Orth, Kansas Precambrian buried hill consisting of fractured quartzite. From Landes et al, 1960.

Apco Oil Pool, Texas: A few wells have produced from fractured Precambrian basement in the Apco field, onshore Texas.

Ames Oil Pool, Oklahoma: This field was discovered in 1991 by Continental Resources (CEO Harold Hamm) and is the result of a meteorite strike in late Ordovician time which formed a circular astrobleme. Cumulative production figures through the end of 2007 show17 million barrels of oil and 80 billion cubic feet of gas. The Arbuckle Formation's share of production was 11 million barrels. However, most of the oil production is from Precambrian-age fractured and brecciated granite of the central uplift according to R.R. Donofrio, 2007. A single well produced at an IP of about 1,500 BOPD from fractured crystalline basement in the Ames oil pool. About 15 wells produced oil from fractured Ordovician carbonates. I am continuing my research on Ames especially to determine how much oil and gas has been produced from the basement.

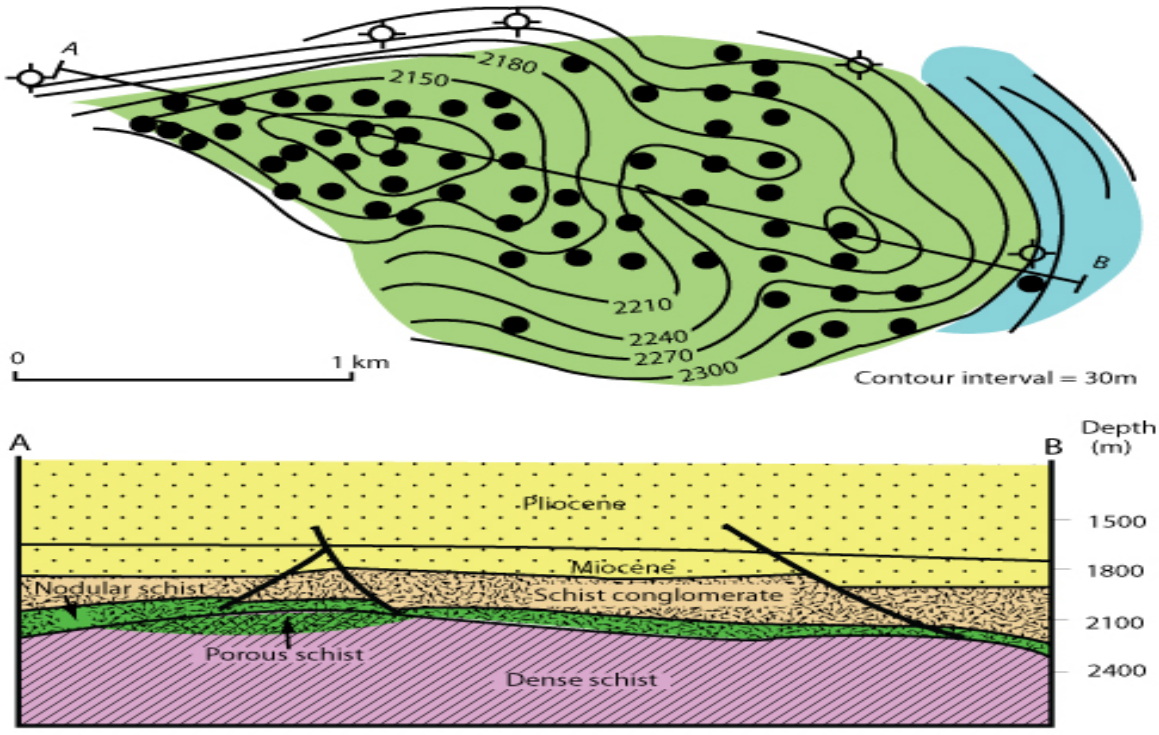
California Basement Oil Pools: Oil production of up to 20 million barrels of oil has been produced from basement in fields in California although typically those pools have produced little more than 2 million barrels of oil. The reservoirs are Jurassic-age schists and meta-sandstones so these are not geologically equivalent to the oil pools which have produced in Kansas and Texas.



Map showing the main Californian gas and oil wells of El Segundo, Santa Maria, Wilmington, Playa del Ray, and Edison. The fields circled in green produce oil from basement reservoirs. (Landes et al. 1960).

Figure 3. Oil fields in California which produce from basement. From Landes et al, 1960.

Continued – see next page



Cross-section through the El Segundo field, California. The reservoir is in fractured Jurassic schists in the west and schist and conglomerate in the east. The average depth of the oil basement production is 2300 m. (Landes et al. 1960).

Figure 4: El Segundo field, California. The reservoir is Jurassic fractured schist in the west half of the field and schist conglomerate in the eastern half. Oil tested up to 4,500 bopd (27 degrees API gravity crude). Average depth of production from 7,000 to 7,200 feet. From Landes et al, 1960.

The following is a summary of key information on California's basement oil fields: (1.) **Playa del Rey Field**, Santa Monica area, reservoir is fractured schists (2.) **El Segundo Field**, fractured Jurassic schists (3.) **Santa Maria Field**, Santa Barbara area, fractured sandstone basement (4.) **Wilmington Field,** Long Beach area, 22 million barrels produced from fractured Jurassic schists (5.) **Edison Field**, Bakersfield area, 20 million barrels produced from fractured Jurassic shists.

Very little detailed information has been published on the American basement oil fields. The oil produced from these fields is nowhere near the volumes of oil produced in countries like Vietnam and China. However, the existence of extensive onshore infrastructure - pipelines, gathering stations, nearby refineries, excellent production contracts with minimal taxation - can make small amounts of oil or gas to be very profitable.

Canada: Unexplored but Significant Potential

I have always been perplexed that there has never been oil or gas produced from the basement in the WCSB. I believe this is because this play is little known within the Calgary “oil patch” which is entirely focused on the WCSB and know little about an “exotic” play like oil and gas in basement. Also, most exploration wells avoided basement since it was traditionally known as “tight” or “tombstone”. Consequently, there has never been a deliberate, basement-focused exploration program in the WCSB. The closest to this was an exploration well drilled in 1994 just west of Fort McMurray, AOC Granite 7-32-8-W4 which drilled through over a mile of granite 1,822 meters (5,978 feet) to a total depth of a total depth of 2,363 meters (7,688 feet).

This well was also known as the “Hunt Well” since it was promoted by Calgary geologist Charles Warren Hunt. The Hunt Well will be reviewed in my presentation as an example of a basement exploration well which I would have never recommended. In my view, a better area to explore for oil or gas in Precambrian basement in the WCSB is the Red Earth – Nipisi area where oil is produced from Devonian-age Gilwood sands overlying Precambrian basement. This is an area where the focus of the geologists was on the Gilwood and the potential of oil and gas in basement was unrecognized to this very day.

Continued – see next page



Figure 5. Granitic core from the deepest section of the Hunt Well (below 2,300 m, 7,590 ft), northern Alberta. The diameter of the core is 4 inches (10 cm). Note the absence of fractures, this granite is totally tight. From: Majorowicz, J., et al, 2014, Geophysical Journal International.

Conclusions and Recommendations

Prospective areas exist in the USA and Canada for oil and gas in basement. These areas have never been the subject of deliberate, highly-focused exploration in the underlying basement.

Exploring for oil and gas in basement rocks takes a special “mind set” since this is much different to exploring in sedimentary rocks. Worldwide analogues need to be studied in order to understand the geological ingredients necessary for commercial successes in basement and to understand why some of such fields ultimately can turn into commercial failures.

Leading edge 3D and 4D+ seismic is critical in this exploration and requires teams of experienced geoscientists (geologists and geophysicists) and reservoir engineers to ensure success. In basement oil pools which have proven oil accumulations, more oil could be produced by drilling horizontal or near-horizontal wells. The wells should be oriented to intersect perpendicularly the dominant fracture system. Wells which have encountered oil or gas in basement should be

thoroughly tested to determine possible pressure drawdowns indicating the near-presence of possible water zones. Lastly, those exploring for oil or gas in basement must always remember that this is a high-risk play but when successful it can be very rewarding for the investors as well as the host countries. With ongoing advancements in leading edge seismic technology, what was formerly high risk can be substantially derisked.

Summary – A Wide Range of Opportunities

In summary, exploring for oil and gas in basement in the USA and Canada is unquestionably high risk. But leading-edge 3D and 4D+ seismic technology can substantially reduce the risk and significantly increase the chance for success. If such exploration is successful, this then opens up a wide range of follow-up opportunities which will have been significantly derisked.

The follow up opportunities may be in extensive fracture “nests” or extensive fracture “corridors” within the basement. Furthermore, in situations where faults in basement propagate vertically, thick oil-bearing or gas-bearing fracture “silos” could be discovered in the overlying sediments using 3D and 4D+ seismic technology.

BIOGRAPHY

I am Holland-born but Alberta-raised with a B.Sc. in 1971 from the University of Alberta and a B.A. in Economics in 1981 from the University of Calgary. I first learned about basement oil and gas reservoirs forty years ago when I worked in Sumatra on the development of the Beruk Northeast field which produced oil from fractured basement. I subsequently published on Beruk Northeast in the 1984 proceedings of the Annual Convention of the Indonesia Petroleum Association in Jakarta. Thereafter, I wrote a paper in the special publication “*Hydrocarbons in Crystalline Rocks*” of the Geological Society of London published in 2003. I have continued to closely follow basement oil and gas activity for over four decades and have presented and written extensively on basement reservoirs, exploration, and best practices at numerous conferences, conventions, and symposiums worldwide. Locations are as follows:

Asia: Jakarta & Singapore
Middle East: Istanbul
Europe: London & Kazan-Russia
Africa: Lagos, Abuja, Luanda & Cape Town
North America: Calgary, Houston, & Pittsburgh
South America: Buenos Airies

My most recent presentation on oil and gas in basement was at the 2024 AAPG-SEG IMAGE Conference in Houston where I gave a presentation titled “*Exploration and Production in China of Recently Discovered Giant-Size Oil and Gas Fields in Precambrian (Archean) Basement*”. For this presentation, I was awarded the Top Oral Presentation Award in the session on Regional Themes. As a follow-up, the SEG commissioned a podcast on my career as a geoscientist and manager, titled “*Episode 267: What Decades in the Field Teach About Success*”.

I worked for 30 years worldwide with Texaco until Texaco was taken over by Chevron. I have worked for 20 years in Canada, mainly in Calgary although I initially spent 2 years working as a mud-logger on the offshore drilling rigs on the Grand Banks, Newfoundland. I lived and worked for 30 years in Sumatra, Nigeria, and Angola. In Angola, I worked for Texaco, consulted for Tullow Oil and thereafter the American - British consultancy of Gaffney, Cline & Associates. I am a member of the Canadian Energy Geoscience Association (CEGA), legacy Canadian Society of Petroleum Geologists (CSPG), Canadian Society of Exploration Geophysicists (CSEG), the Association of Professional Engineers and Geoscientists of Alberta (APEGA) and the American Association of Petroleum Geologists (AAPG). This includes over fifty years of membership with CEGA, CSEG and APEGA. For more information, I can be contacted at tako.koning@gmail.com or 1-587-284-3411.