MagmaChem
Research Institute

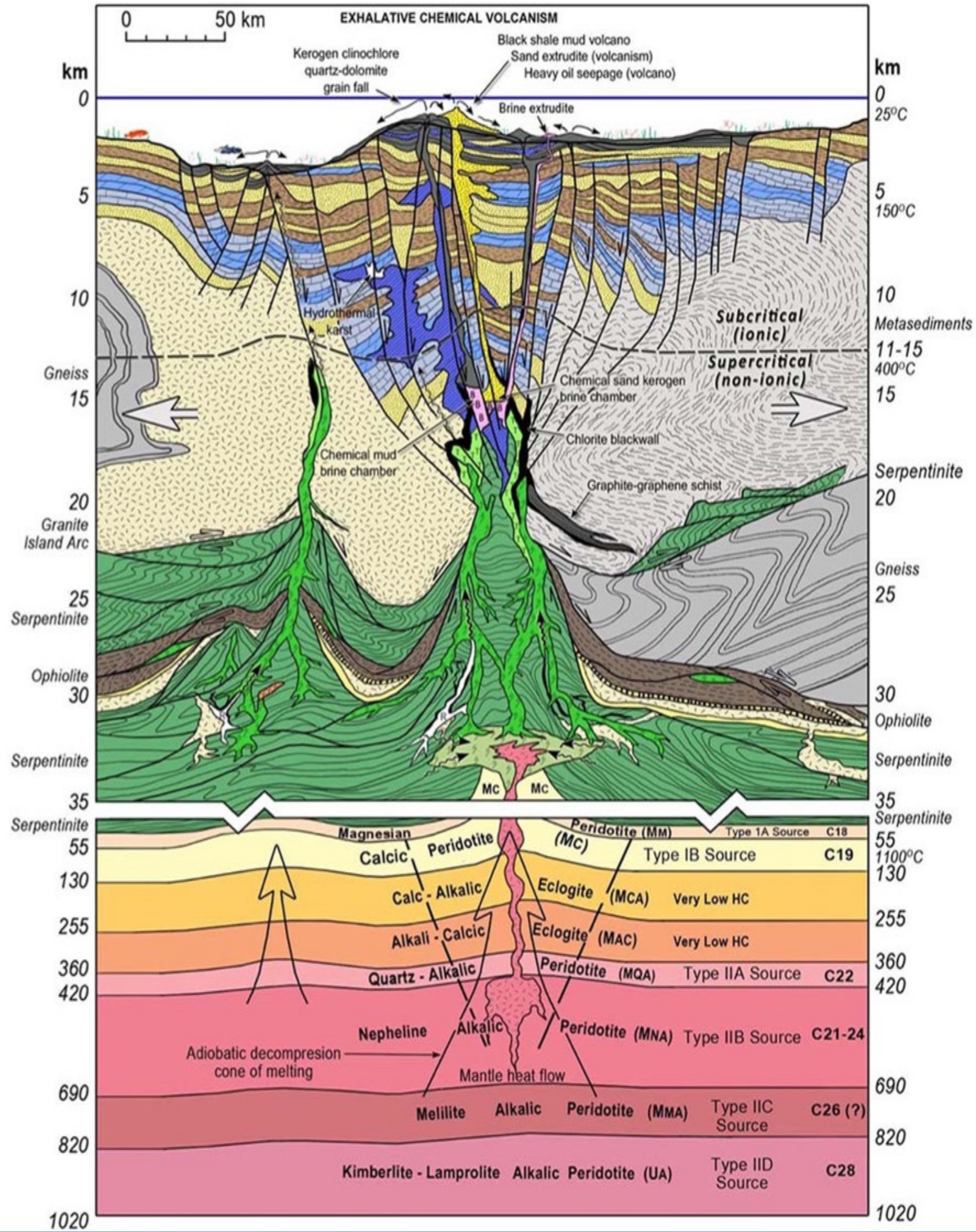
Fall 2020 Webinar Series:

Ultra-Deep Hydrothermal Research

Introduction

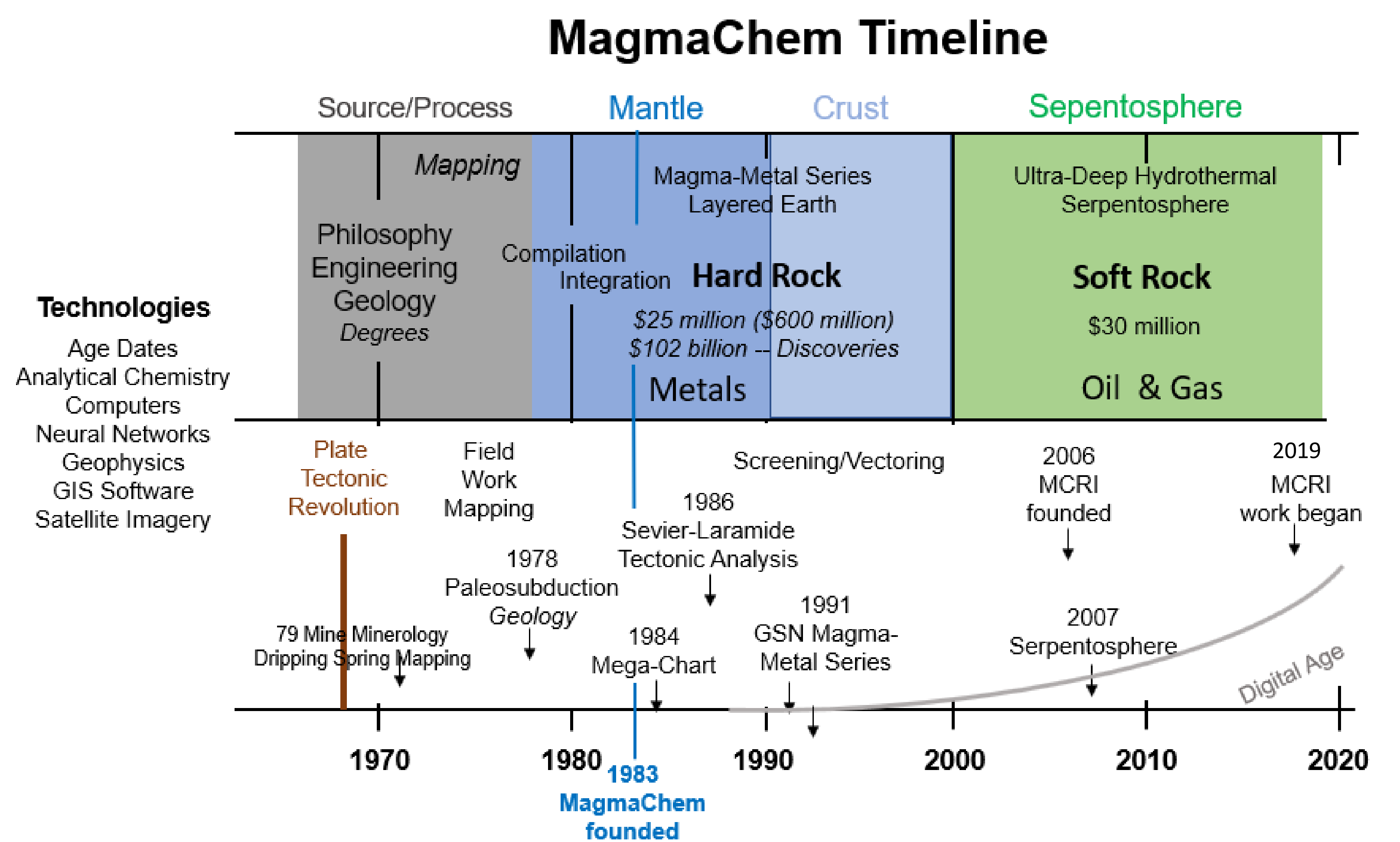
Oct. 1, 2020

www.magmachemri.org



Funding and Projects by Private and Government

MagmaChem Research Institute



A Detailed Background Story

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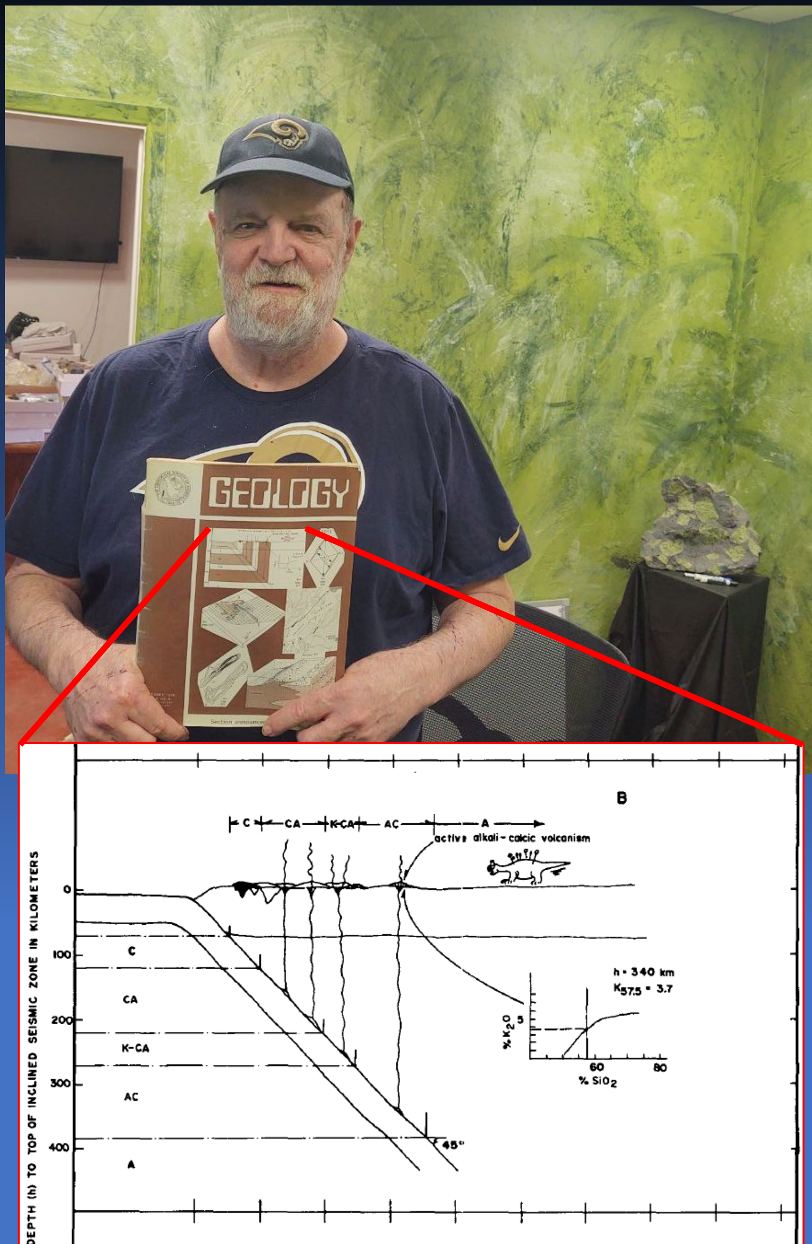

STANFORD UNIVERSITY
STANFORD, CALIFORNIA

Peter —
for your info...
let's go fishing, eh —

DEPARTMENT OF GEOLOGY
School of Earth Sciences

June 12, 1978

Vernon Swanson
Geological Society of America
3300 Penrose Place
Boulder, CO 80301

Dear Vern:

I would like to urge that Geology manuscripts get more expeditious handling before the journal sinks out of sight in trivia as authors with exciting stories to tell go to the competition in Nature or EPSL.

Last fall before the Seattle meeting, I reviewed a really blockbusting piece by Stan Keith, a young guy at Arizona. His tale is going to change the way folks look at southwest geology and ore deposits. I was on a high all week after reading it. He got it in to you before Christmas, I think. It was officially reviewed favorably by Pete Lipman and Eldridge Moores (two good reviewers for it, by the way), but was then turned down in June for reasons of length and writing. If length was a problem, why could someone not count pages before sending it out for review? If writing is a problem, why not ask for revision? Geology has thus lost a hot paper it need not have lost!

In my view, six months for an author to find out that a paper for Geology is too long and too poorly written is just too much baggage for us to haul, prestigious though we be! The competition puts them in print in that time!

Ah, well, I know you get lots of beefs, but I did not want just to sulk about this case, because it is the kind of happening that can force me to advise young authors with skyrockets to avoid Geology like the plague, and I do not want to do that without thrashing around a little bit first. Thus, the message is that we have a bad problem on time delays for Geology, which started with a much shorter time in press than now. If we cannot somehow chop that time, it is going to get more and more boring as the authors with something fresh to say fast vote with their feet and go elsewhere.

I think my deepest concern is the feeling that we are becoming insensitive to the needs of the hotshot geologic authors by worrying overly much about our subscribers. Good papers with spark will draw readers regardless. Dull papers will not draw flies no matter what. People like Stan Keith need care and feeding. Somehow the system ought to tag him as a comer and help him along, rather than building road blocks for him. He does not have to go to GSA, and maybe he will not again. In his shoes, I am not sure that I ever would!

Sincerely,

Bill

W. R. Dickinson
Professor of Geology

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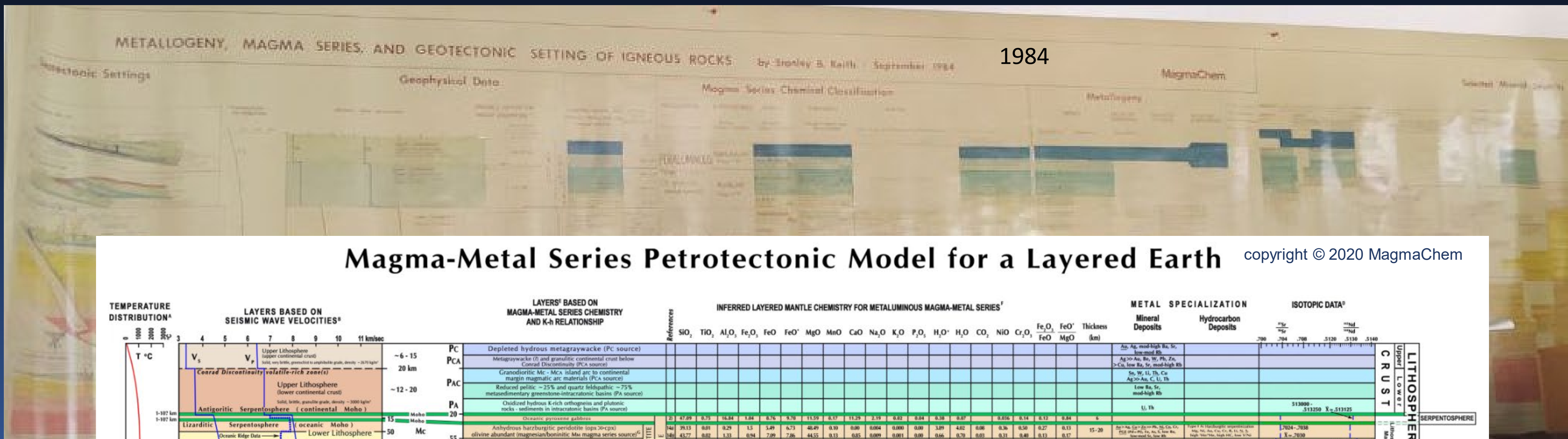
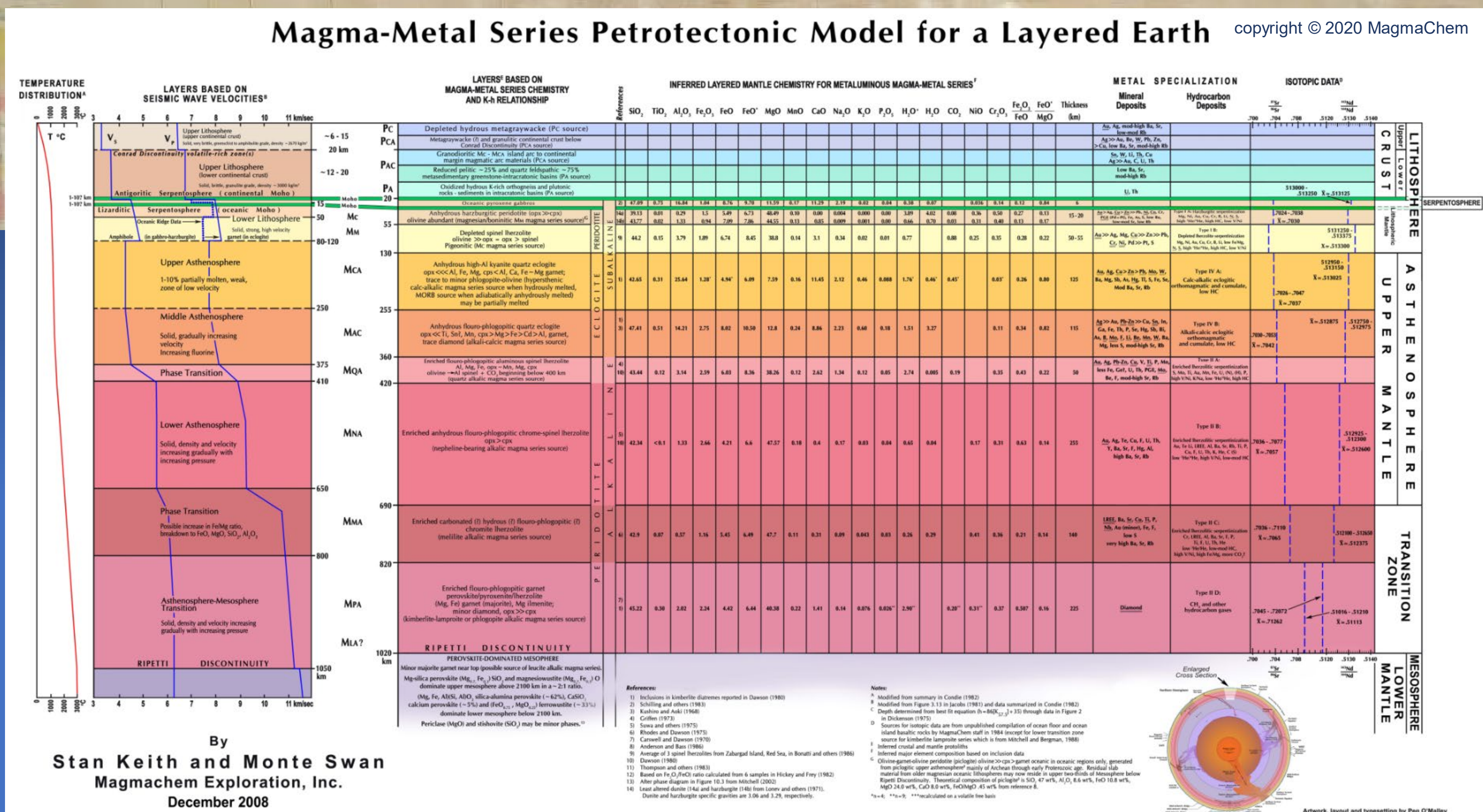


1984



Contributions to Successes - Metals – MagmaChem Exploration

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Gold and Copper Discoveries Predicted by Magma-Metal Series Approach

Mine/Projects	Estimated Resource
Lookout Mountain, Nevada 2006	To be determined?*
Jewett (Crown Zone), Oregon 2005-6	Several thousand tons of +1 opt Gold
Big Springs (701/601), Nevada 2005	To be determined?**
Rio Figueroa, Chile 2005	To be determined!?***
Big Springs (Crusher), Nevada 2005	To be determined!?****
Chuquicamata, Chile 2004	4 billion pounds Copper
Ren, Nevada 2003	1.3 million ounces Gold
Storm-Dee Forty Niner, Nevada 2003	1 million ounces Gold
Ntotorosa, Ghana, West Africa 2000	2 million ounces Gold
SE Ajo, Arizona 1998	2 billion pounds Copper
Espanola, Chile 1997	6 billion pounds Copper
Espanola, Chile 1997	2 million ounces Gold
South Alcaparrosa, Chile 1996	60 million pounds Copper
South Alcaparrosa, Chile 1996	0.15 million ounces Gold
Pascua, Chile, 2000	26 million ounces Gold
Pascua, Chile, 1995	700 million ounces Silver
Tyrone, New Mexico 1994	2.4 billion pounds Copper
South Meikle, Nevada 1992	2 million ounces Gold
Vinasale Mountain, Alaska 1992	655,000 ounces Gold
Trout Creek (Valmy), Nevada 1988	179,000 ounces Gold

MagmaChem Exploration, Inc.
Ideas• Exploration • Discovery for Minerals & Energy

Stanley B. Keith
President

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Email: mcheme@aol.com

CONTRIBUTIONS OF THE MAGMA-METAL SERIES APPROACH TO THE DISCOVERY PROCESS

(as of November 21, 2006)

by Stanley B. Keith

with a section on

The Magma Metal Series Technical Approach

By Stanley B. Keith and Monte M. Swan

and a section on

Magma Metal Series Tools Developed by MagmaChem to Assist in the Identification and Discovery of Mineral and Petroleum Resources

by Stanley B. Keith

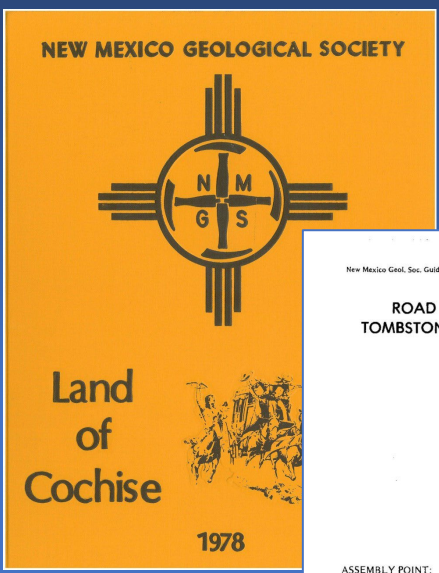
and a section on

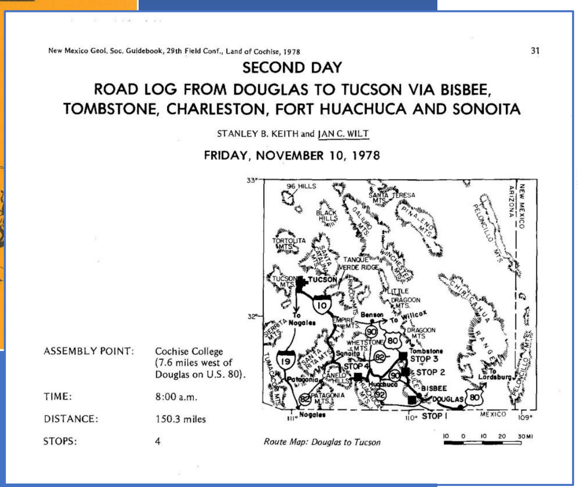
Hydrothermal Hydrocarbons

by Stanley B. Keith and Monte M. Swan

MCRI Team Introduction

Jan (Wilt) Rasmussen earned a Ph.D. in Economic Geology at the University of Arizona and is a Registered Geologist in Arizona. She worked with Stan Keith as a research geologist for the Arizona Geological Survey. was on the Arizona Oil and Gas Commission, worked as a geochemist at Woodward-Clyde, as a permit specialist at SRK Consulting, and was Curator of the Arizona Mining and Mineral Museum.





New Mexico Geol. Soc. Guidebook, 29th Field Conf., Land of Cochise, 1978 31

SECOND DAY

ROAD LOG FROM DOUGLAS TO TUCSON VIA BISBEE, TOMBSTONE, CHARLESTON, FORT HUACHUCA AND SONOITA

STANLEY B. KEITH and JAN C. WILT

FRIDAY, NOVEMBER 10, 1978

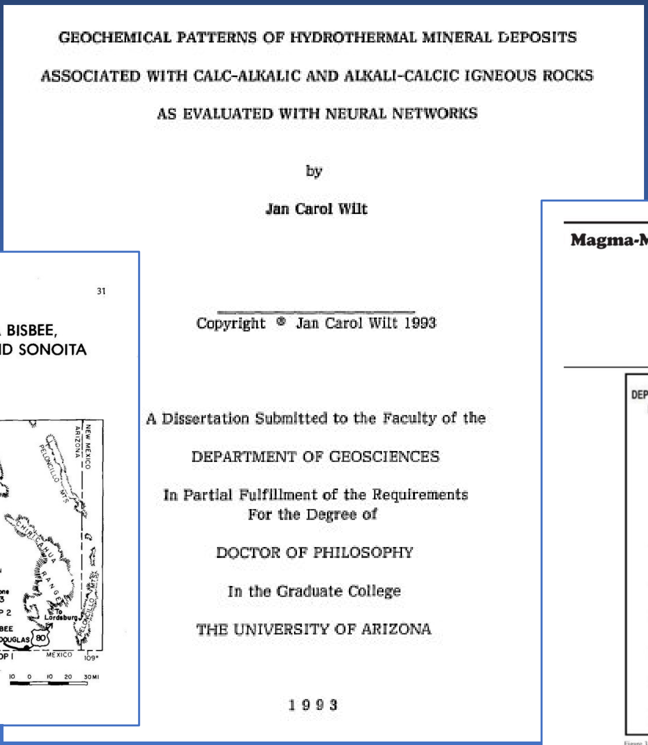
ASSEMBLY POINT: Cochise College (7.6 miles west of Douglas on U.S. 80).

TIME: 8:00 a.m.

DISTANCE: 150.3 miles

STOPS: 4

Route Map: Douglas to Tucson



GEOCHEMICAL PATTERNS OF HYDROTHERMAL MINERAL DEPOSITS

ASSOCIATED WITH CALC-ALKALIC AND ALKALI-CALCIC IGNEOUS ROCKS

AS EVALUATED WITH NEURAL NETWORKS

by

Jan Carol Wilt

Copyright © Jan Carol Wilt 1993

A Dissertation Submitted to the Faculty of the

DEPARTMENT OF GEOSCIENCES

In Partial Fulfillment of the Requirements For the Degree of

DOCTOR OF PHILOSOPHY

In the Graduate College

THE UNIVERSITY OF ARIZONA

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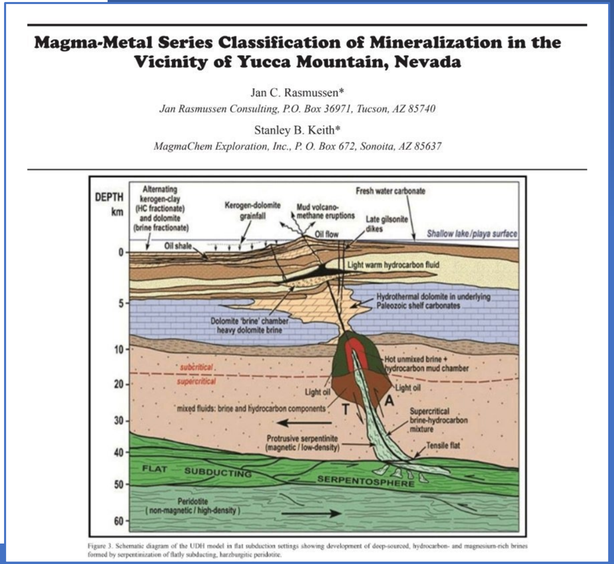

Magma-Metal Series Classification of Mineralization in the Vicinity of Yucca Mountain, Nevada

Jan C. Rasmussen*
Jan Rasmussen Consulting, P.O. Box 36971, Tucson, AZ 85740

Stanley B. Keith*
MagmaChem Exploration, Inc., P. O. Box 672, Sonoita, AZ 85637

MCRI Team Introduction

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Monte Swan has B.S. degree in Geological Engineering from Michigan Technological University and a M.S. in Geology from the University of Arizona. After working as a research geologist for Kennecott's geological research group and as an Exploration Geologist for Newmont Gold he co-founded MagmaChem Exploration, inc.

Graduate School: 1970's

Outcrop, 2018

MCRI Team Introduction

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Dan Laux earned B.S. in Geology at Arizona State University. He was one of the earliest employees of Stan Keith at MagmaChem Exploration full time most of its first decade and then off an on numerous projects until the present day.. Dan is real data hound and has build many of the MagmaChem electronic maps and accompanying data bases using Mapinfo.

I started working for MagmaChem Exploration in September 1984. Initially, my work involved the drafting of the Exxon Compilation Igneous Time-Slice and Mineral District maps for the western United States. Afterwards, I worked on Mineral District maps for Idaho and Oregon at 1:1,00,000 scale. In 1985-86, I worked a comprehensive compilation of the metallogeny of Nevada at 1:250,000 scale. Next was compilation of British Columbia for an association of clients

1986: Prospecting/Drilling in the Orocopia Mountains for Orvanna Resources. 1987: Prospecting/Drilling in the Chase-Bagdad area for Cyprus Minerals. During the period 1988-1990, regional reconnaissance prospecting programs were done for Hecla (CA-NV), American Copper & Nickel (NV-OR), and BP Minerals (NV). In 1990, I began work with Metal Dispersion projects. Metallogenetic compilation of Chilean systems was done for LAC Minerals (1994) and continued with Phelps Dodge (1996-97). A 3 year compilation/prospecting project was undertaken in northern Nevada in 1994-1996 for Uranerz; it was during this project that I became involved with GIS. In 1997-98, a GIS compilation of Alkalic and Carlin/Round Mountain-type Au systems in British Columbia in association with Rubicon Minerals for Cyprus Minerals. Phelps Dodge sponsored a major compilation project for the Caribbean/Central America region in the late 90s.

1999-2000: Oversaw the conversion of FMC/Phelps Dodge Mexico compilation to a GIS format (MapInfo).
2001: Oil & gas compilation for the State of New York.
2002: Metallogenic compilation of Newfoundland for Rubicon Resources.
2005: Supervised drilling program at the Yuma King property.
2009: Great Basin Slab compilation for Stat Oil.
2013-2015: Hydrocarbon compilation of the North, Norwegian, and Barents Seas, and on-shore compilation of ultramafics and related metallogeny in Norway for Det Norske.

MCRI Team Introduction

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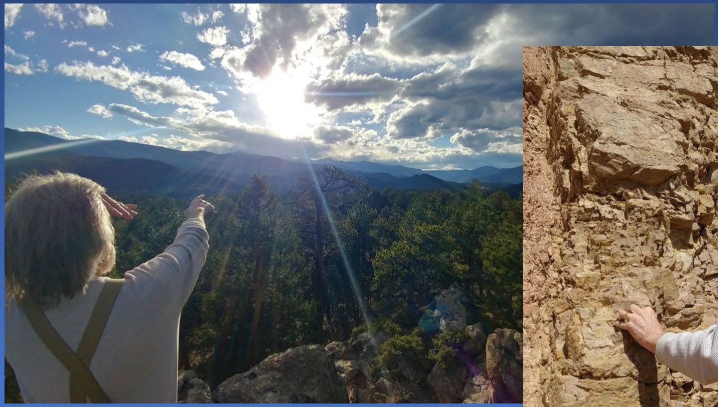
Troy Tittlemier has a M.S. in Geology from University of Texas of the Permian Basin. Former senior geoscientist business development manager of a private equity E&P energy company. Troy is a SW section AAPG delegate and counselor for the energy and minerals division, and co-founder of the PBE Podcast.



Anomalies and Problems for Conventional Petroleum Model

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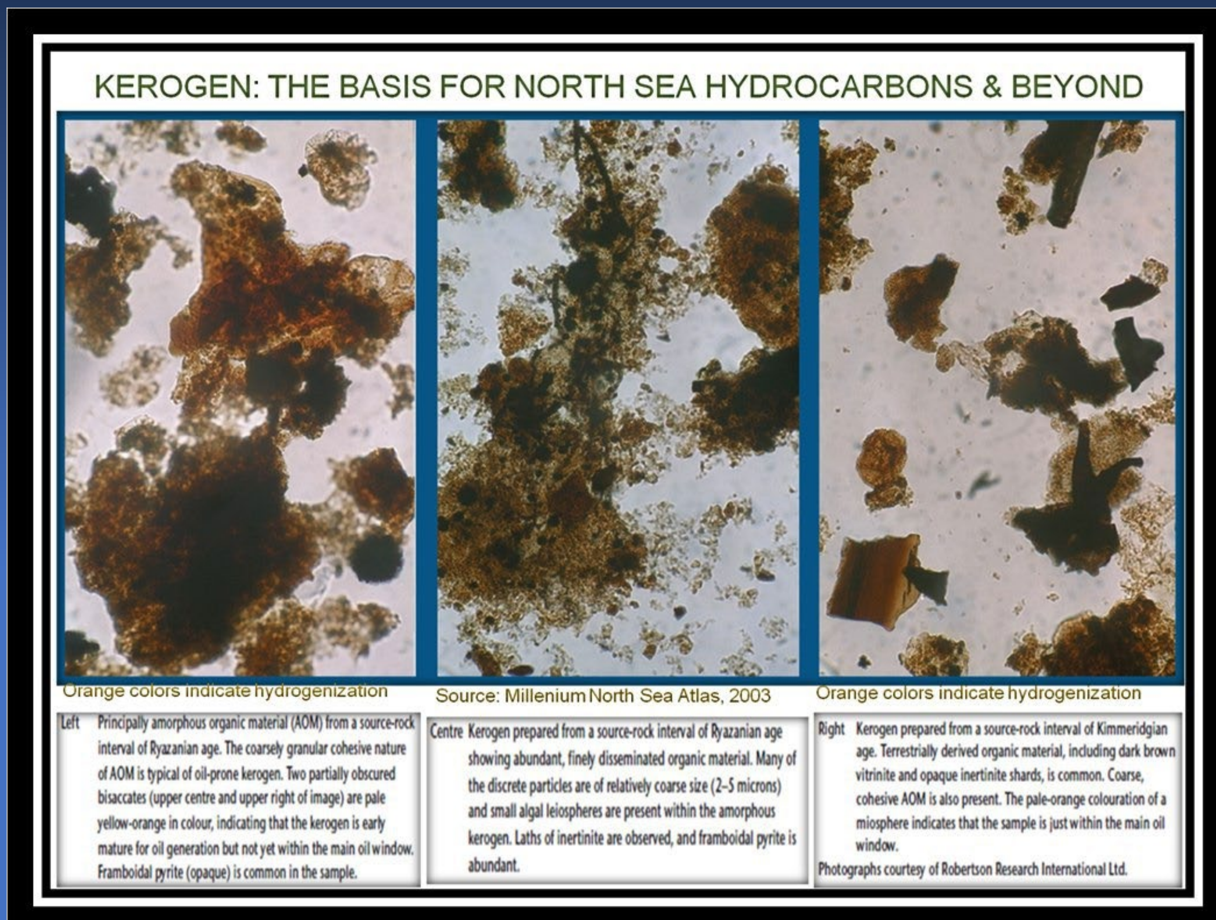
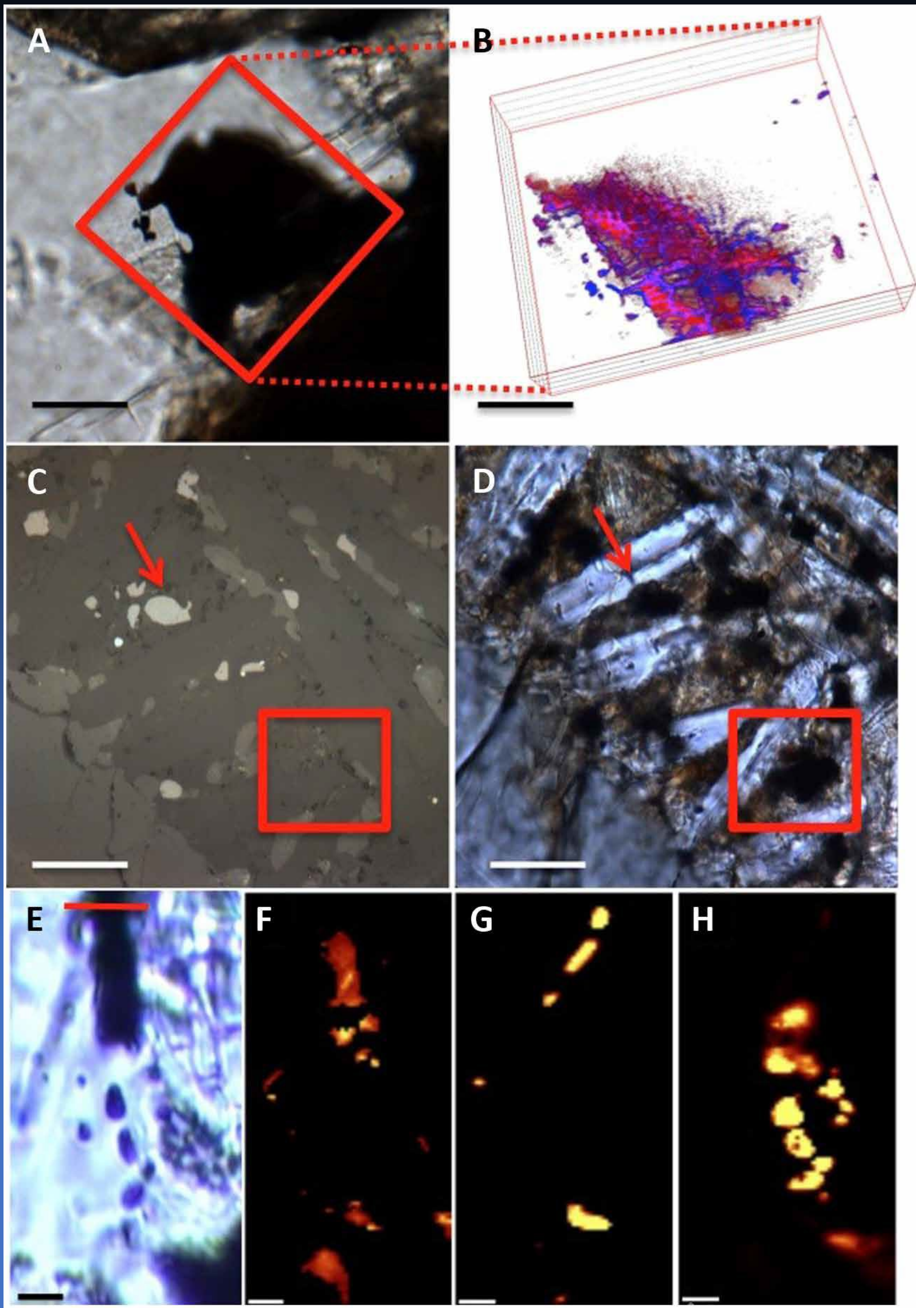
- Kerogen Anomalies
- High Energy Mineral and Rock Anomalies
- Black Shale Problem
- Salinization/brine Problem
- Mud Volcanism Issue
- Oil Problems
- Biosphere Issue

Kerogen

Primordial Kerogen - Kerogen is solid-state, mostly polyaromatic hydrocarbon (PAH). Kerogen occurs in meteorites, Mars, and micro-planets, and in mantle rocks, serpentinites, and talc where no biospheric material is present. Kerogen also occurs in sapropelic, chemical coals where no obvious biospheric material is present. However, in the conventional oil model, the sapropelic coals and their more diluted carbonaceous black shale counterparts are considered the main source of liquid oil and represent more hydrogenated forms of kerogen. The kerogen definition thus is easily broadened to non-biospheric terrestrial and cosmic materials. Interestingly, the class of humic coals in which vitrinite kerogen is found does have abundant evidence of the biosphere, mainly as plant trash. Yet the humic coals have been shown to be a poor oil source.



Kerogen



Martian Kerogen – The recent discovery of hydrogenated kerogens on Mars in the absence of any biosphere component, strongly points to the abiogenic of kerogen hydrogenation. The abundance of chlorine and chloro-hydrocarbons as well as the planetary scale presence of "pesky" perchlorates which are toxic to any known biosphereic material. Adds additional support to the abiogenic oil generation hypothesis.

Light and CRIS of the relationship between magnetite and MMC in the meteorites studied. (A) Transmitted light microscopy image of a darkened area within maskelynite, entrained in the subsurface to the thin section in NWA 1950 (scale bar, 100 μm). The red box indicates the area for three-dimensional (3D) mapping by CRIS. **(B) A 3D depth profile composite CRIS image of magnetite (red) and MMC** (blue) (slices are 2 μm apart) from the area denoted by the red box in (A) (scale bar, ~60 μm). (**C and D) The same area of Nakhla mesostasis imaged in transmission and reflection** showing a magnetite grain beneath the surface of the section (marked by red arrows) (scale bars, 20 μm). **(E) Transmitted light image of a magnetite-rich area** (dark vertical band) in the Tissint meteorite [scale bar, 20 μm; red line on top delineates the area where a focused ion beam (FIB) section was removed for analyses; see Fig. 4]. **(F to H) CRIS imaging maps taken at 8 μm into the surface of the thin section** and depth profile of the feature shown in (A); (F) magnetite, (G) pyrite, and (H) MMC.

From Steele and others, 2018

The presence of kerogen in Martian meteorite material establishes the presence of a hydrocarbon that potentially may have been polymerized into alkylated hydrocarbons early in Martian history when extensive brine oceans were developed.

Kerogen

Old Kerogen – Oil is present in Precambrian Archean rocks as old as 3.5 Ga, as at Strelley Pool and North Pole in northern Australia. Significant biosphere material, such as plant mass, was not available for kerogen formation until Ordovician time at about 450 Ma.

THE OLDEST KNOWN KEROGEN IN THE WORLD

Kerogen-rich silica from the black chert dike/vein feeder system beneath the 3.4 Ga Strelley Pool carbonate-silica-hydrocarbon hydrothermal exhalite deposit. The crude layering in the sample probably reflects flow layering in the dikes.

Kerogen

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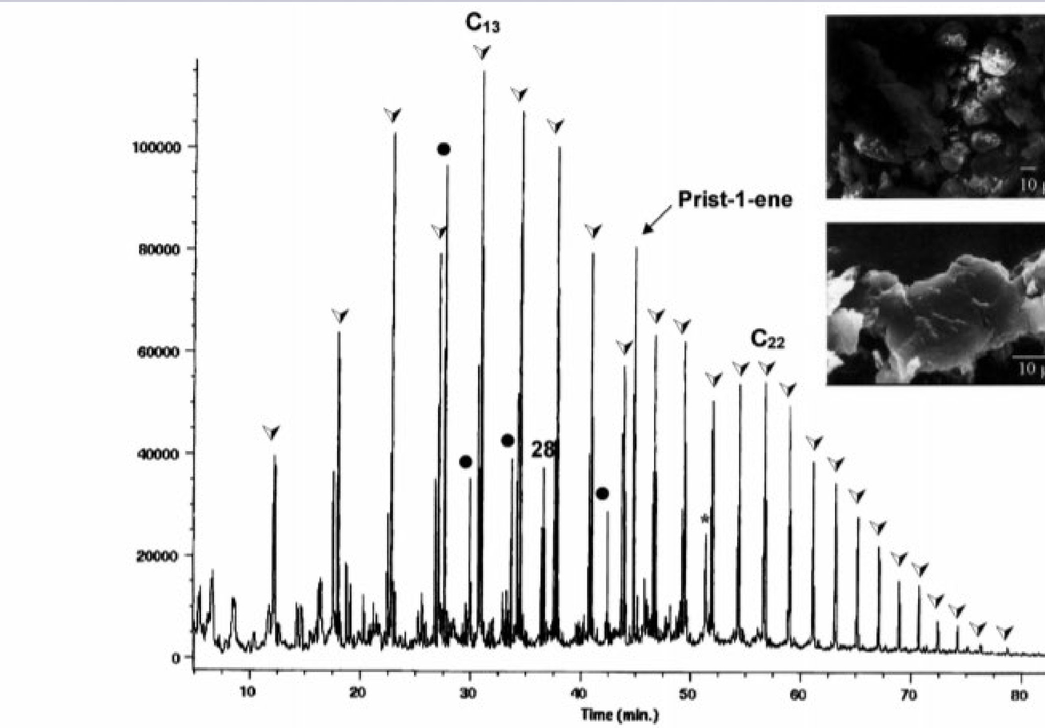
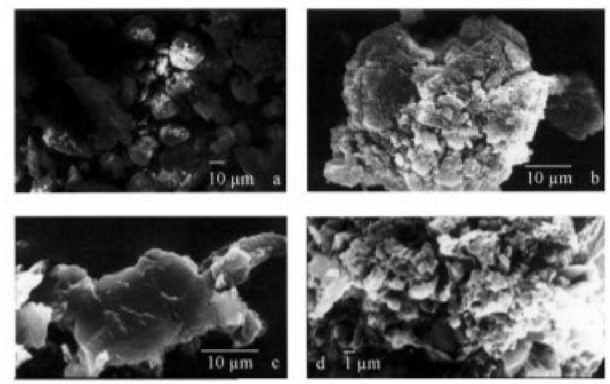
Young Kerogen – Anonymously young kerogen has been found in places like the Holocene section in the Danube delta. The kerogen occurrences in recent sediments are anomalous because, in the bio-maturation model, it takes time for the biogenic material to mature into kerogen material. In the UDH model, the kerogen is made at depth under hydrothermal conditions at some time prior to eruption. The kerogen in the mud-brine plume is then erupted as completely 'mature' kerogen into the depositional environment.

YOUNG KEROGEN





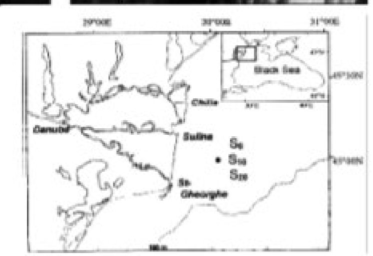


Fig. 1. Map of the northwestern Black Sea, the Danube delta, and the sampling site.

Fig. 8. Mass chromatogram (m/z 57) of the 650°C Curie-point pyrolysate of S_{20} KL showing alkane distribution. ▼, n-Alkanes; ●, branched alkanes; *, C_{16} fatty acid; **28**, methoxyphenol. From Garcette-Lepecq and others, 2000

- The kerogen generation process is anything but fossil as this kerogen like material in these Holocene surface sediments (decades old ?) from the toe of the Danube Delta.

Kerogen

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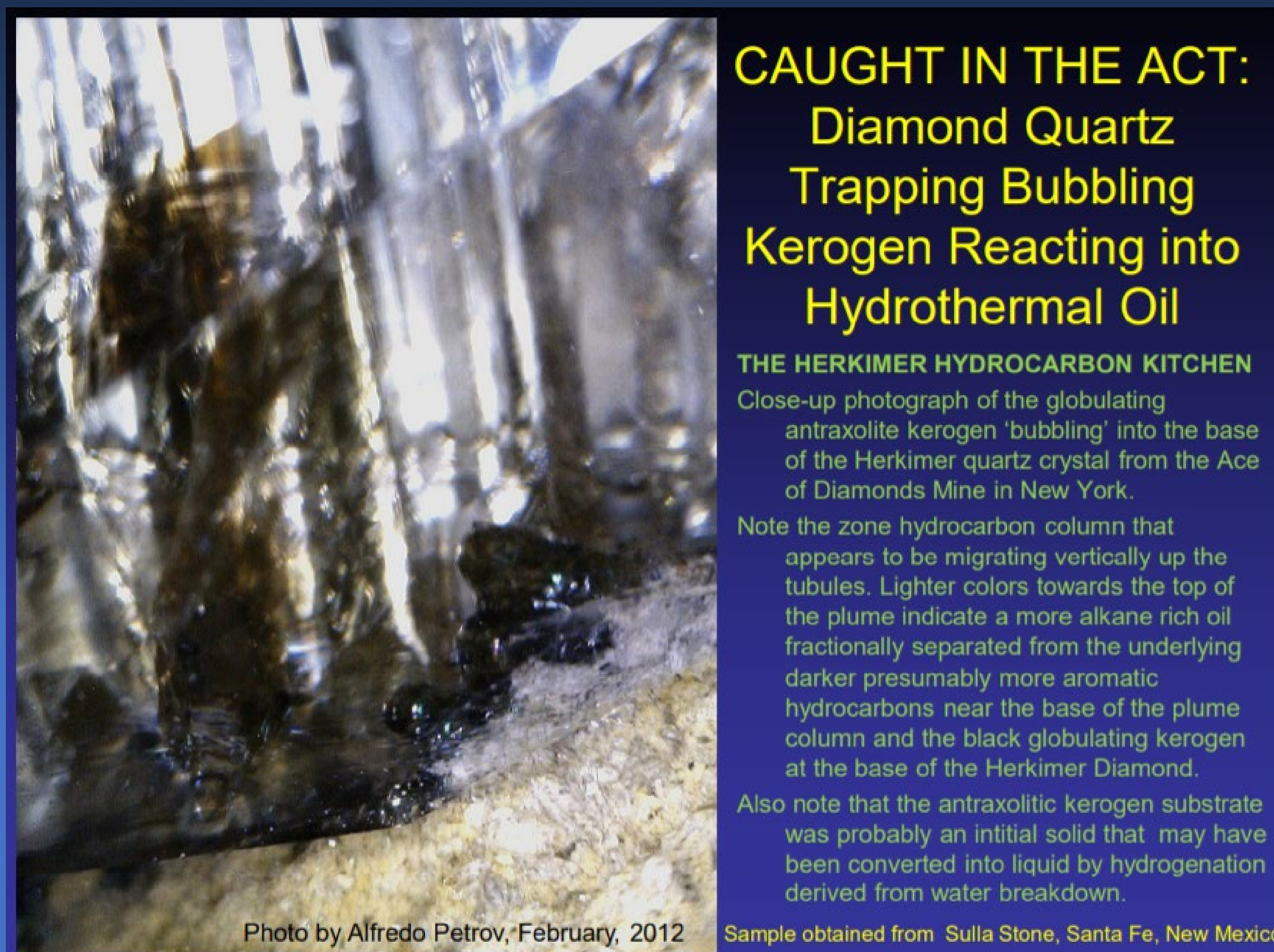
Mineralogy Anomalies – The presence of kerogen has been established in talc (e.g. at Talc Lake in British Columbia), in lizardite serpentine (numerous localities including Vulcan Peak in Oregon, and in serpentinite diapirs in California. The California serpentine diapirs include those diapirs adjacent to the Santa Maria oil basin and the New Idria diapir near the Coalinga oil fields. Kerogen also occurs in hydrogarnet in central Atlantic serpentinites and rodingite dikes in a serpentinite pipe at Lion's Head, California. Kerogen also occurs in authigenic, micro-'Herkimer diamond' quartz at numerous localities, such as Permian Basin gypsite rock, the classic Herkimer 'diamonds' of central New York, and in south central Pakistan. Kerogen also occurs in high-temperature illite in black shales, such as those in the Kupferschiefer of southern Germany and southwestern Poland.



Kerogen

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Metallic Elemental Anomalies – Metals, such as nickel, vanadium, platinum group elements (PGEs), and others, are present in oils and in kerogen in kerogenous black shales (e.g., Monterey Formation). The presence of these metals implies non-biospheric sources, such as peridotites. In some cases, the metallic anomalies are high eough to constitute ore material, for example the Kupferschiefer copper shales of northwestern Germany and southwestern Poland. The chemo- stratigraphy of the metal occurrences is systematic, in that progressively increasing metal contents correlate with progressively hydrogenated kerogen. The kerogen is hydrogen-rich enough to chromatographically resemble oil in some cases.

Kerogen

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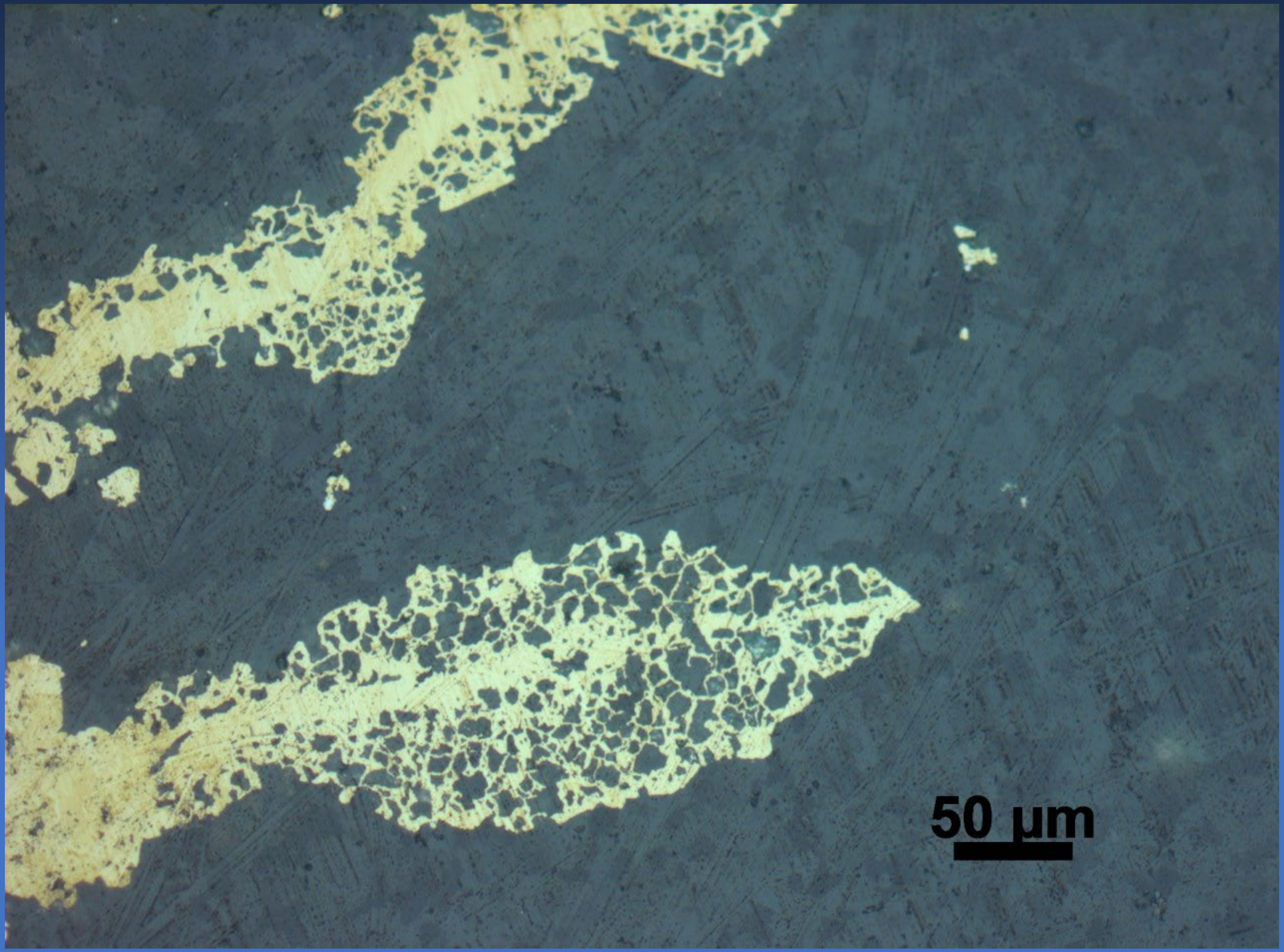
Kupferschiefer High-Temperature Sulfide Minerals Anomaly – The Kupferschiefer (copper shale) deposits have been the principal source of copper in Europe for centuries and are notable for their strong association with highly bituminous, carbonaceous black shales. Their origin has been much debated. Current science has shown that the co-existing bituminous shales, sulfides, muscovite, dolomites and marls may have formed between 340˚ and 380˚C, which are temperatures about three times higher than of those of the conventional oil window and may have occurred in the context of hydrothermal mud volcanism.



Kerogen

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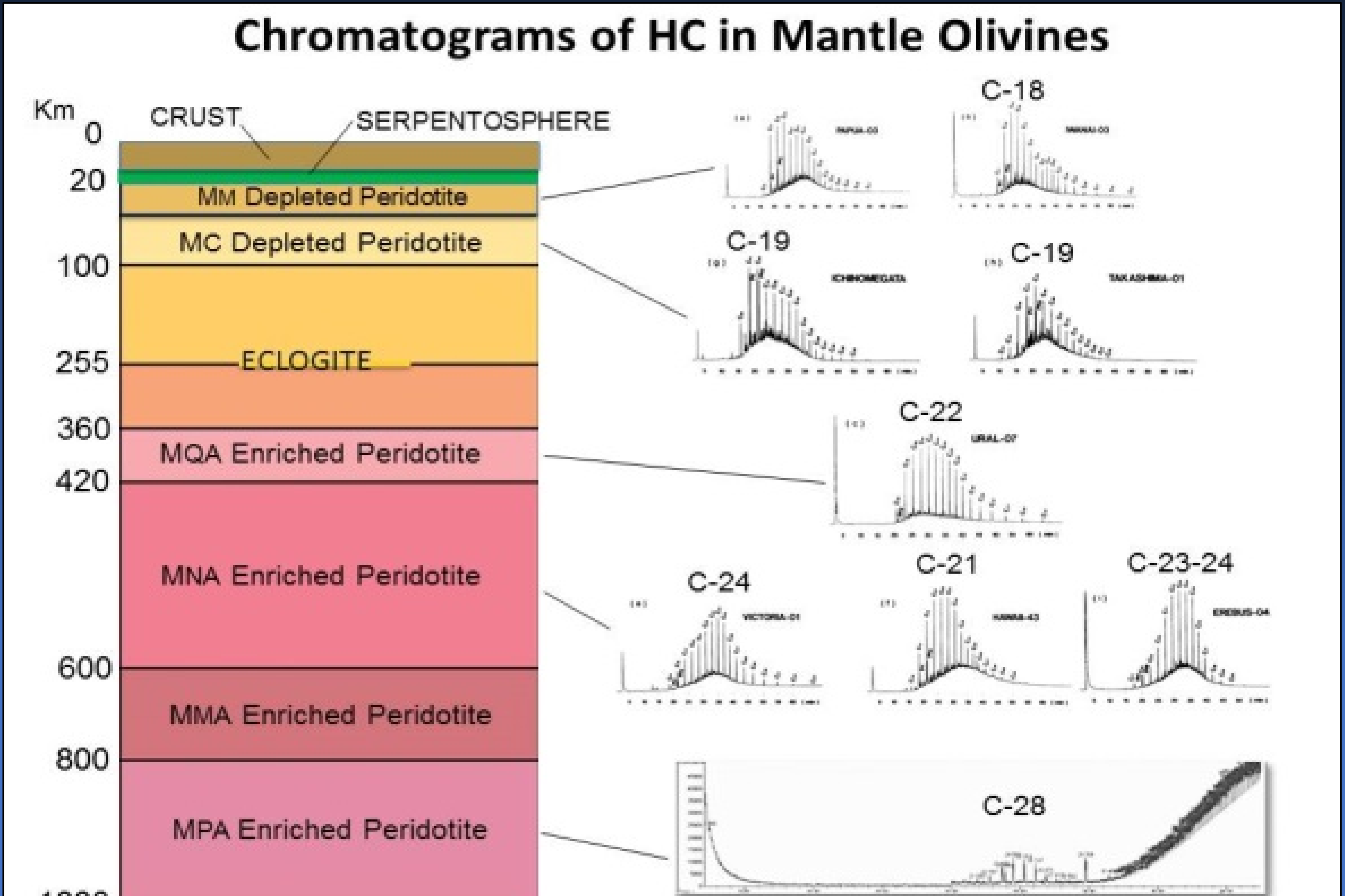
Kerogen 'Biomarkers' Anomalies – Biomarkers, especially phytane and pristine, are found in serpentine, meteorites, and mantle rocks. The presence of these hydrocarbon compounds in non-biospheric material is so widespread that they can no longer be regarded as contamination. Hydrocarbon compounds, such as phytane and pristine, are not really plant biomarkers and, more generically in the context of the proposed UDH paradigm, these hydrocarbon coumpounds should be considered to be simply hydrocarbon markers.



Kerogen

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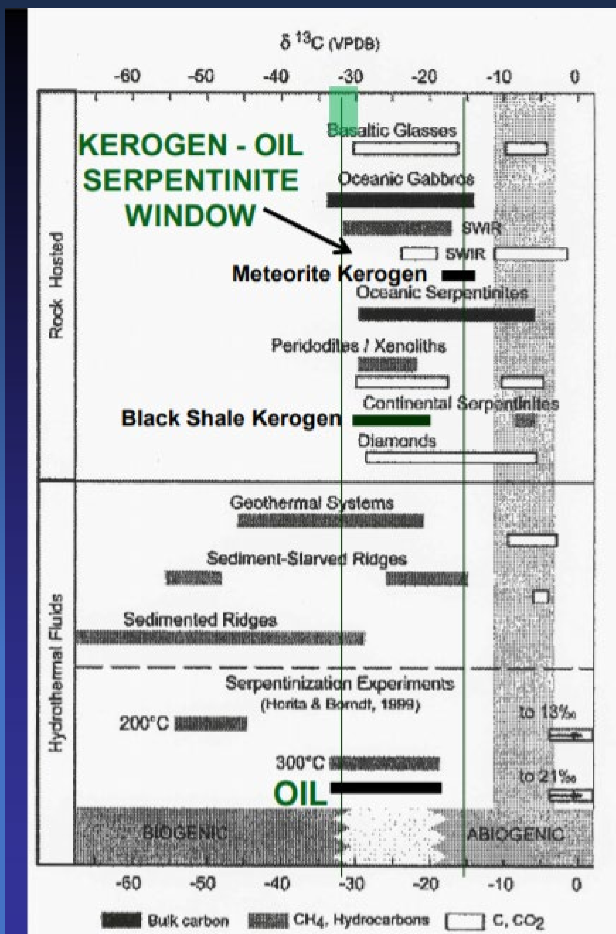
Carbon Isotope Anomaly – There is a match between carbon isotopes in serpentinite, black shale, kerogen, coal, and oil. Carbon isotopes have been widely used to connect carbon isotopes extracted from biospheric with those obtained from serpentine-kerogen rich, black shales and oil. However, a closer look at the data reveals that black shale kerogen, coals, and oil deposits exhibit $\delta^{13}C$ ratios between -32 and -18. Biospheric materials exhibit much lighter values of $\delta^{13}C$ ratios that range between -60 to -30. Lewan (1997) showed that carbon isotopes show little temperature variation ($\delta^{13}C$ ratios ranging from -24 to – 26 at Standard Temperature Pressure conditions up to 400˚C). These observations suggest that carbon isotopes in oils and related carbonaceous materials directly reflect the carbon isotope makeup of the serpentinite precursor.



Modified from Fruh-Green and others, 2004

Ranges of carbon isotope ratios ($\delta^{13}C$) of CO_2 (open bars), CH_4 (grey bars) and bulk, non-carbonate bulk carbon in submarine and geothermal settings

- Black shale kerogen (like serpentin-Ite) falls in the 'twilight zone' between the biogenic and abiogenic windows in $^{13}C/^{12}C$ carbon isotope space.
- Other important hydrocarbon-related phenomena that fall in the same window include methane produced from olivine during experimental serpentinization at 300º C, reduced carbon forms in mantle peridotite xenoliths and diamonds, and methane-hydrogen fluid inclusions in oceanic gabbros.
- Normal microbially produced methanes are much lighter. It appears that serpentinite hydrocarbons are a much more straightforward source!?
- **Perhaps most importantly, petroleum $^{13}C/^{12}C$ carbon isotope ratios largely overlap with the serpentine-kerogen window.**

High Energy Mineralogy and Rock Anomalies

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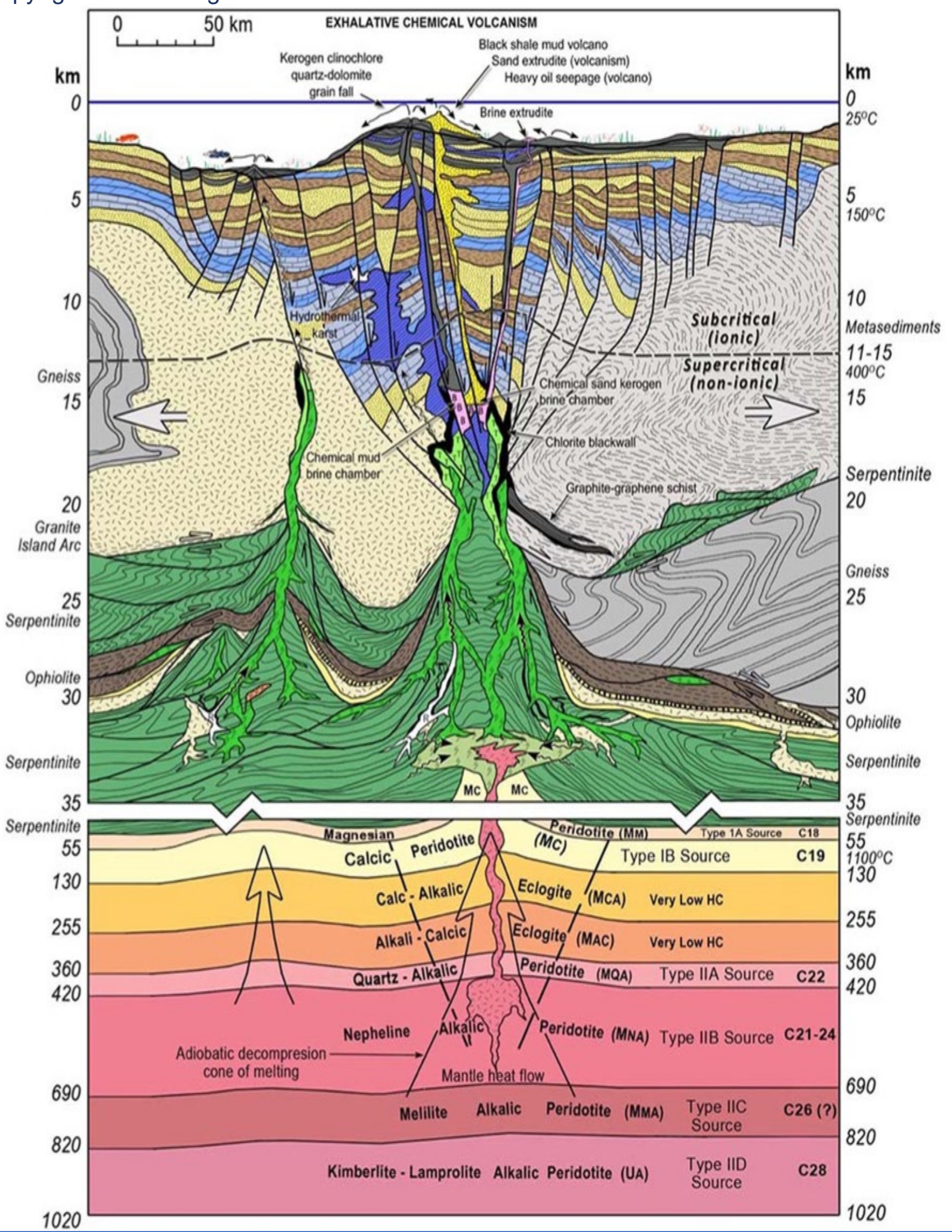
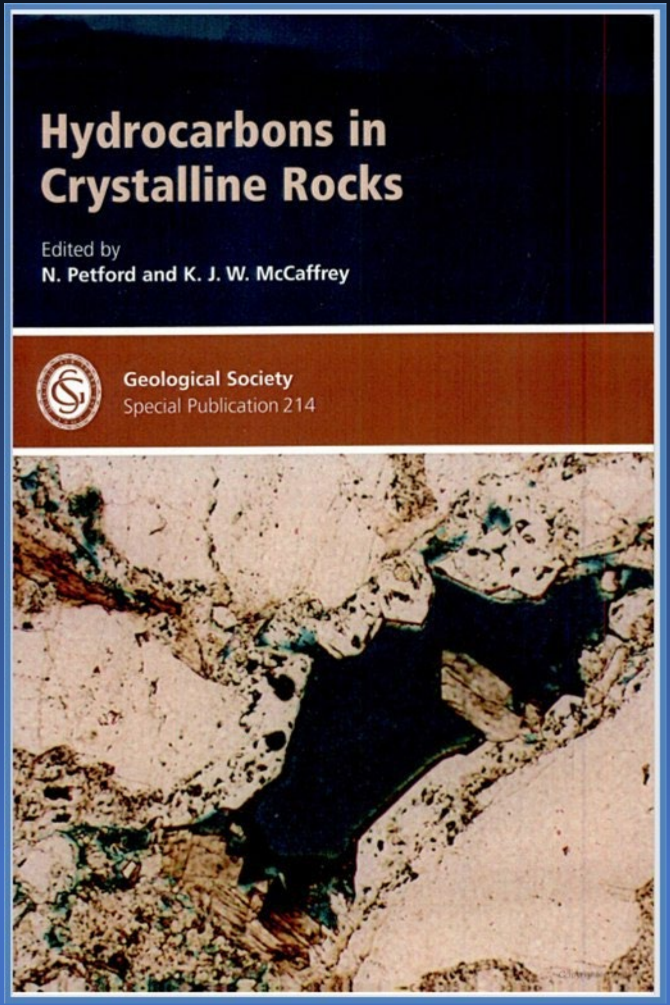


Entropy Problem – The conventional model of the maturation of oil requires the addition of energy, such as that supplied by heating during basin burial. This is contrary to the concept of entropy where the system loses energy as it proceeds. The UDH model proceeds from high-energy hydrothermal sources to low-energy trap sites and, like hydrothermal metal deposits, has no entropy/energy problem.



Serpentine and Other Crystalline Host Rocks – Some 400 medium to large oil fields from around the world are known to host oil. Examples include, serpentine hosted reservoirs in Cuba, the Santa Maria basin in California, the White Tiger giant oil field in Vietnam (hosted in pre-Cambrian granite), the Edison oil field Northeast of Bakersfield, California (hosted in Mesozoic Schist), and the world-class Maracaibo oil fields in Venezuela (in part, hosted in Mesozoic schist), and many more crystalline hosted reservoirs listed in

High Energy Mineralogy and Rock Anomalies

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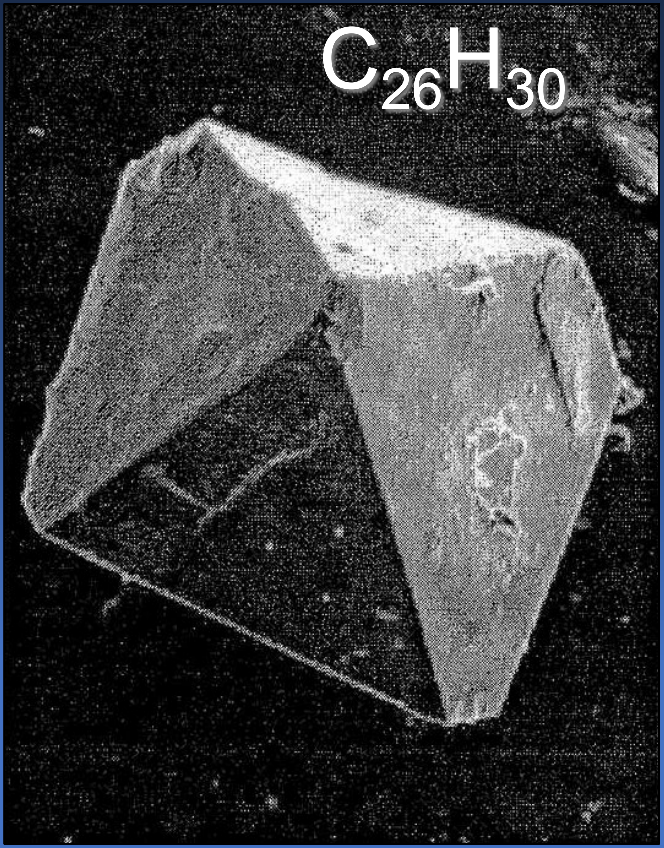

Diamondoids – In the early 2000s, diamonoid hydrocarbons were discovered in bituminous pipe scales in Louisiana pipelines and later distilled from Lousiana crude oils. Diamondoid compounds have a diamond structure identical to those that classically occur in high-temperature, high-pressure, kimberlite pipes. Subsequent research has shown that diamondoids are present in almost every oil. Hydrous pyrolysis experiments have shown that diamonoid formation is maximized in California oils at 375-475°C. These high termperature compounds are highly anomalous to the conventional oil model. The conventional model typically interprets these compounds as a highly refractory indicator left over from ultimate oil maturation. In contrast, the UDH model interprets these high temperature hydrocarbons as the beginning of the hydrothermal oil process, not the end of the hydrocarbon degradation process.

High Energy Mineralogy and Rock Anomalies

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Dolomite Origin – How did mountain-sized dolomite masses get deposited? Hydrothermal dolomite is a common so-called diagenetic mineral in petroleum deposits. A major problem is the ubiquitous, high-mass occurrence of mountain ranges made of dolomites. Examples are the Dolomite Alps in northeastern Italy, the massive replacement of Cambrian carbonates along the Kicking Horse Rim in British Columbia, and the gigantic reefs, such as El Capitan in the Permian Basin. It is difficult to envision a source of magnesium for such large-scale, mountain-sized deposits of dolomite. Saabka reflux, which is the normal sedimentological explanation, is inadequate. The magnesium mass balance problem is easily explained by UDH, where deep-sourced, magnesium-rich brines ascend upward from serpentinite 'kitchens' in underlying ultra-mafic basements beneath petroleum deposits in the upper crust.

El Capitan, Permian Oil Basin

High Energy Mineralogy and Rock Anomalies

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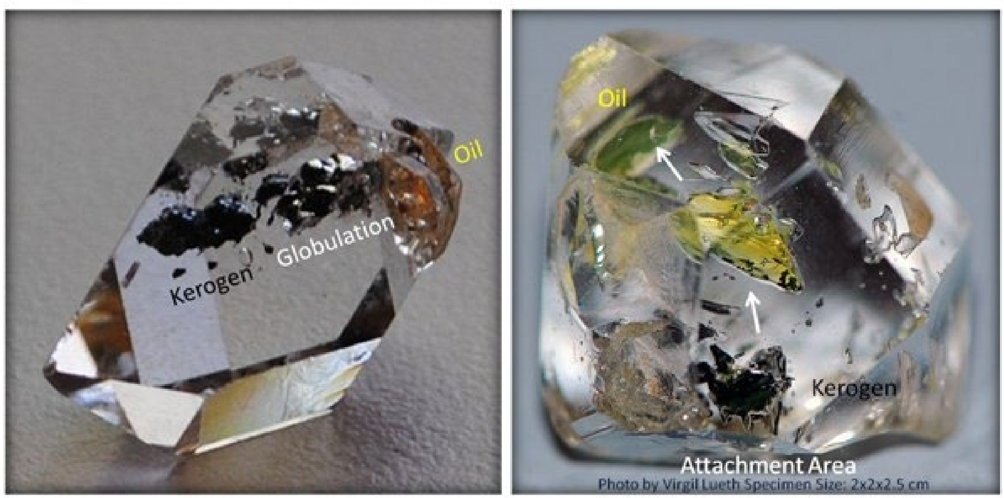
High-temperature, Micro-Herkimer Quartz in Reservoirs – Authigenic silica commonly occurs as euhedral, equant, Herkimer-style, quartz crystals and is an increasingly common occurrence in many oil fields. Notable examples include oil-bearing Herkimer-style quartz in the Permian Basin, Alberta heavy oil sands, and the Herkimer hydrocarbon area in northern New York. Textural relationships in the Herkimer quartz indicate that complete sequences exist from solid-state kerogen near the basal attachment point of the quartz crystal, progressing through globulating kerogen/pyrobitumen in the middle part of the growth history, and locally going all the way to liquid state oil near the tips of the quartz crystal. The oil-bearing 'diamond' quartz crystals from Pakistan that are popular with many mineral collectors are particularly notable in their inclusion of oil. Fluid inclusion data suggest that the formational ages for these petroliferous oil formation sequences are in the neighborhood of 200°C, which is two times higher than the conventional oil window.

CAUGHT IN THE ACT: Diamond Quartz Trapping
Kerogen Globules Reacting into Hydrothermal Oil in Pakistan 'Diamond Quartz'

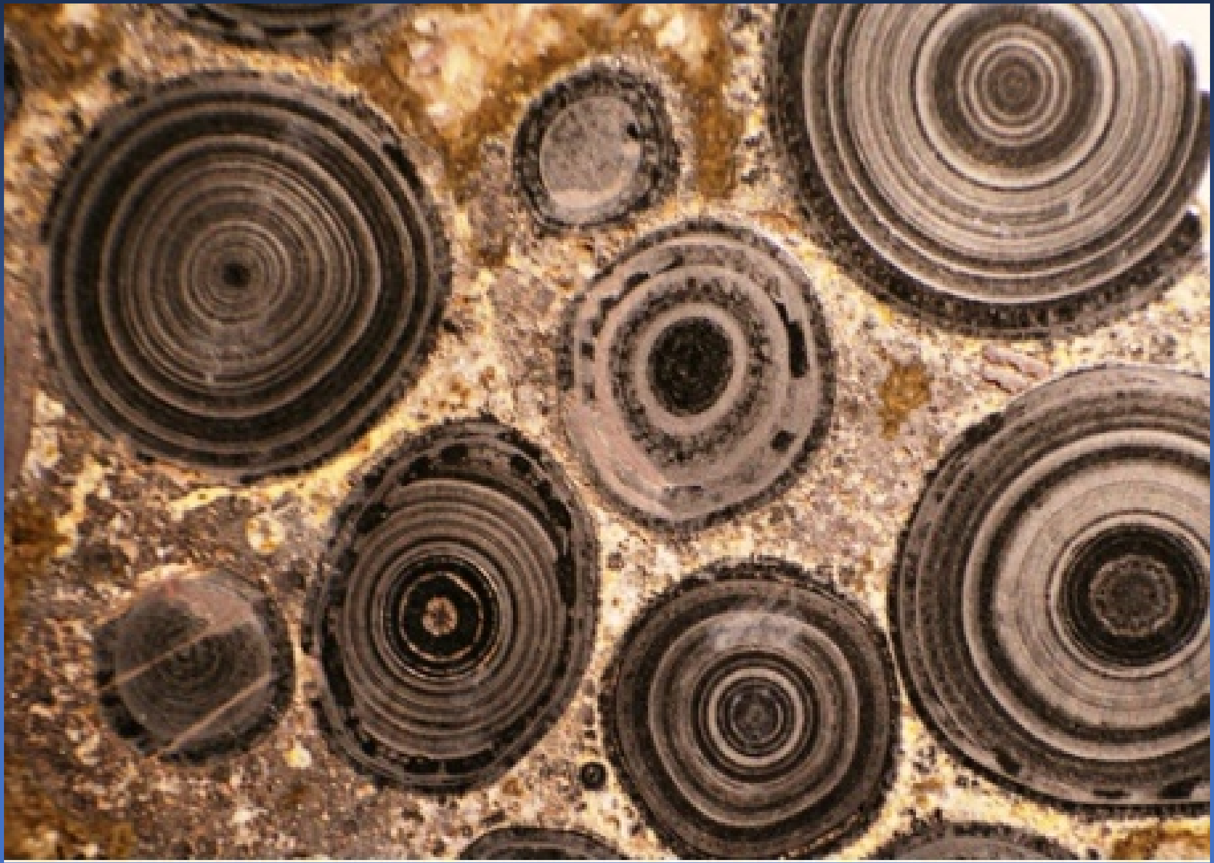


- In the Herkimer/Diamond Quartz at the left the reaction procedes from left to right along the 'C' crystallographic axis to produce liquid oil at the young termination end of the crystal on the right.
- In the Herkimer/Diamond Quartz at the right the reaction proceeds from the kerogen trapped near the early basal attachment area upward and to the left toward the younger terminated end of the crystal.

High Energy Mineralogy and Rock Anomalies

MagmaChem Research Institute

Calcite Calci-Sphere Magnetite Talc Ooid Anomaly – The existence of of high-temperature ooid magnetite and talc spheres in anomalous, low-temperature, petroliferous, depositional settings (such as the Herkimer 'diamond' quartz and hydrothermal dolomite) is highly anomalous for the low temperature hydrothermal oil model (80 - 135^{o}C or 100 - 160^{o}C, based on experimental, dry pyrolyis heating of oils at Standard Temperature and Pressure). In the context of a UDH ascending high-density brine, precipitation of the solute component will take the form of spherical concretions, where new speherical layers will form around a seed. The precipitation will be guided by changes in fluid pressure, coupled with the concentration of a given solute component. The orbicules are erupted at high velocities during eruptive episodes where they are transferred to the water column and then rained out into the chemical sediments.



Ooidal Magnetite spheres floating in salt/halite matrix, Tunguska Region Irkutsk Oblast, Russia (source: mindat.org) Found in a breccia pipe at the **Korshunovskoye iron deposit**

Black Shale Problem

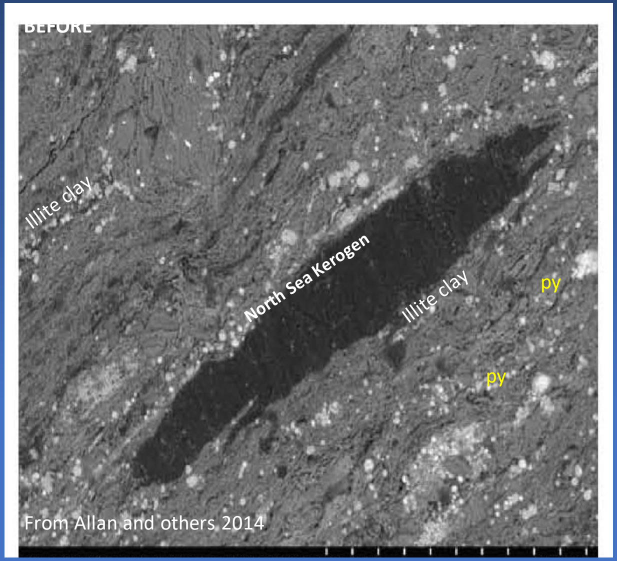
MagmaChem Research Institute

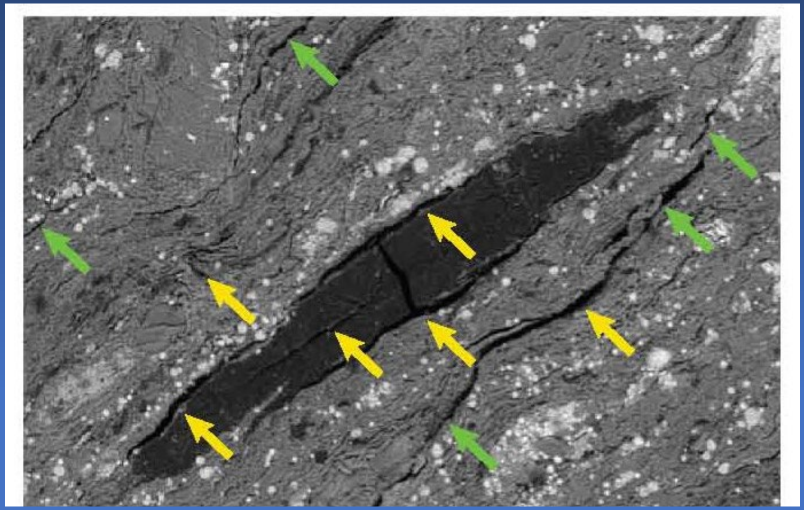
Black Shale as Both a Seal and a Reservoir – Supposed black shale source rocks have now been shown to contain more oil than conventional sand reservoirs that commonly lie beneath their black shale lithocap seals. Black shale is now recognized as a reservoir rock leading to the routinely applied aphorism, ‘My source rock is now my reservoir rock’. Self-sourcing black shales are almost the rule, not the exception. As such, black shale oil reservoirs are highly anomalous to the conventional oil model. In the UDH model, the black shale facies are produced by carbonaceous shale, mud volcanism, which is the same age as the oil formation, as now validated by Re-Os dating. In the UDH model, petroliferous black shales represent hydrothermal, carbonaceous exhalate, low-density muds that were developed in chemically and density zoned mud chambers that are consanguineous with oil formation via hydrogenation of more hydrogen-poor kerogen. This hydrogenation invariably accompanies mud volcanism of the same age as the hydrogenation and oil formation.

Black Shale Problem

MagmaChem
Research Institute

No Permeability in Black Shales – The only porosity in black shales is kerogen porosity. As petrographic understanding of black shale geology has evolved, it has become increasingly apparent that the only open space porosity in oil shales is in the kerogen itself. This texture can be interpreted as a volatile escape texture, which in this case is oil exsolution and escape from the local kerogen source. This process is analogous to gas vesicles in basalts, where high temperature gases are exsolved and escape from the basalts. In some cases, the oil forms, but does not escape, and is trapped in place. These reservoirs commonly exhibit little fracture connectivity. Connectivity must either be induced or greatly enhanced by fracking. Hence, it is difficult to envision oil migration into such reservoirs from an external source. Oil fields at Gohta in the Barents Sea of northern Norway are an outstanding example of *in situ* oil. From a UDH perspective, the reservoir at Gohta represents oil formation at the same time as the reservoir and the hosting mud volcano edifice.

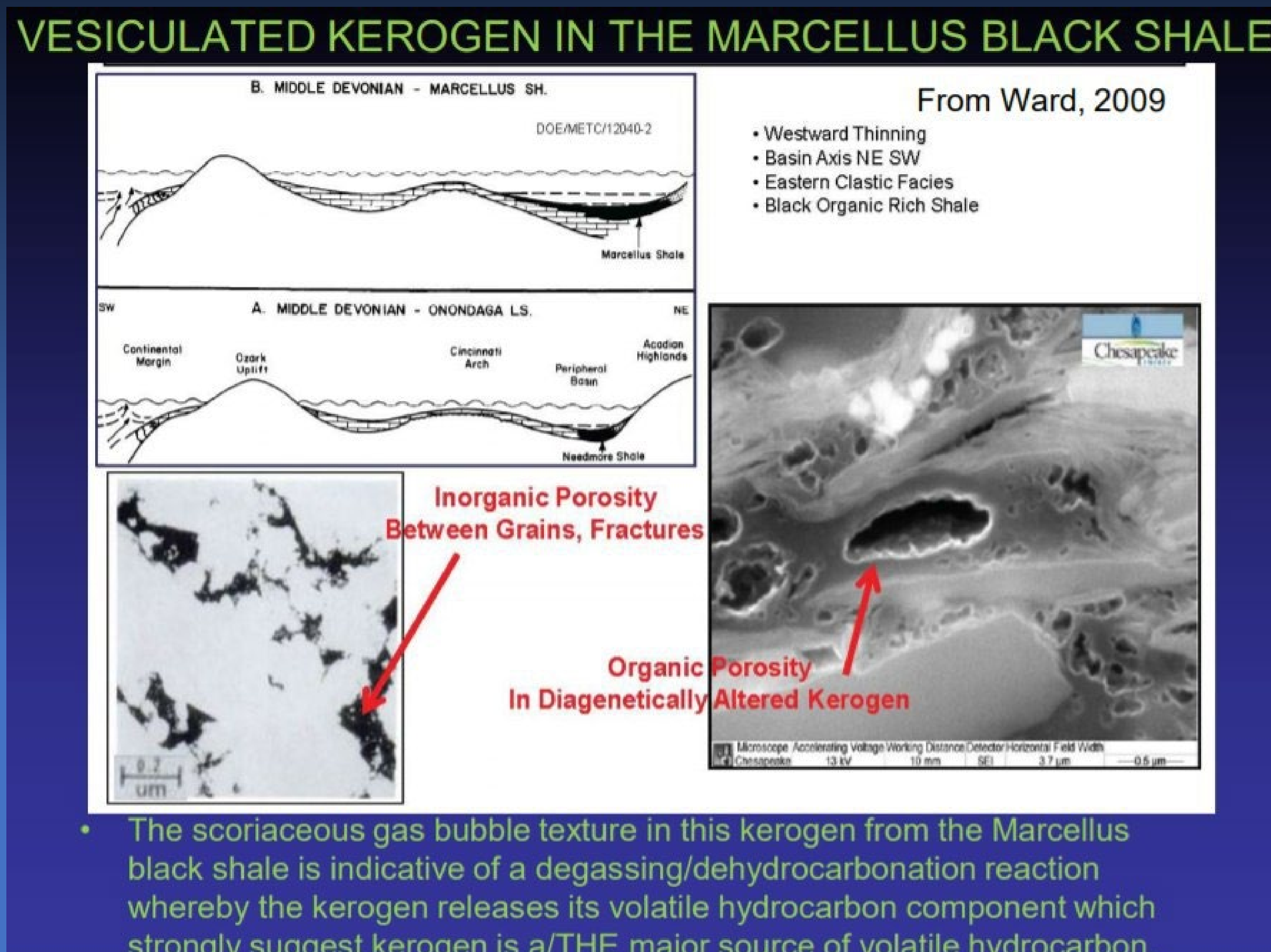




Arrows point to Oil bearing microcracks of various kinds

Black Shale Problem

Kerogen Porosity Anomaly – In tight, nonporous black shales, the only porosity textures exist in kerogen itself. Connectivity for oil passage into the porous kerogens is generally absent and is difficult to explain by the source-migration-trap model. The UDH model suggests that the vesicular appearamce (similar to volcanic scoria texture) instead represents an escape feature produced by escaping petroleum volatiles. These volatiles are induced by removal of the labile component of hydrogenated kerogen produced by hydrothermal pyrolysis during the emplacement of UDH hydrothermal plumes.



Black Shale Problem

MagmaChem Research Institute

Mud Provenance Problem – Where did the immense amounts of mud come from in the black shales without a highland or sedimentary source? Like hydrothermal dolomites, carbonaceous black shales commonly display huge volumes of mud that are not easily explained by detrital sources. Indeed, the carbonaceous black shale muds represent chemical muds, not detrital muds. Together with their anomalous metal contents, these chemical muds can be viewed to have been derived from deep, ultramafic chemical sources beneath a given petroleum 'basin'. The Permian Basin is an outstanding example where black carbonaceous muds commonly contain clinochlore, serpentine, and kerogen and occur in volumes that cannot be explained by local, subaerial, detrital sources. Deep, UDH chemical sourcing is a more logical alternative source.

TALC, SERPENTINE, & CLINOCHLORE IN THE DELAWARE BASIN

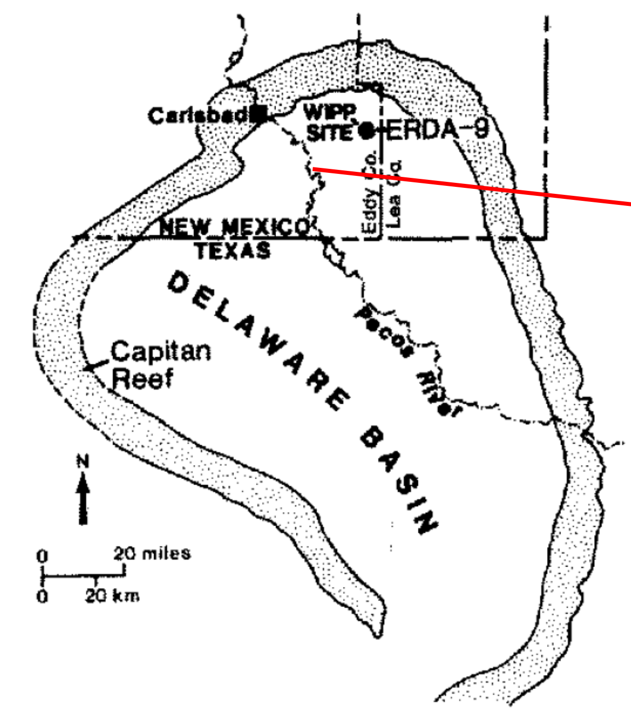


Figure 2. Location map of the Delaware Basin showing the Capitan Reef, the WIPP site, and the ERDA-9 drill hole from Anderson (1982).

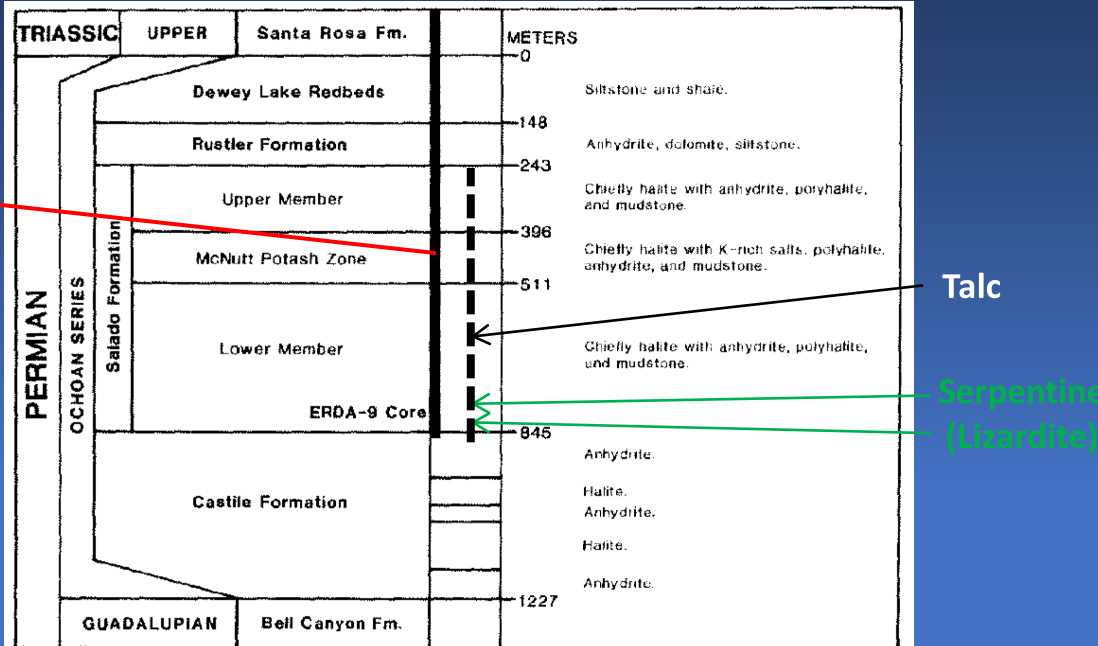
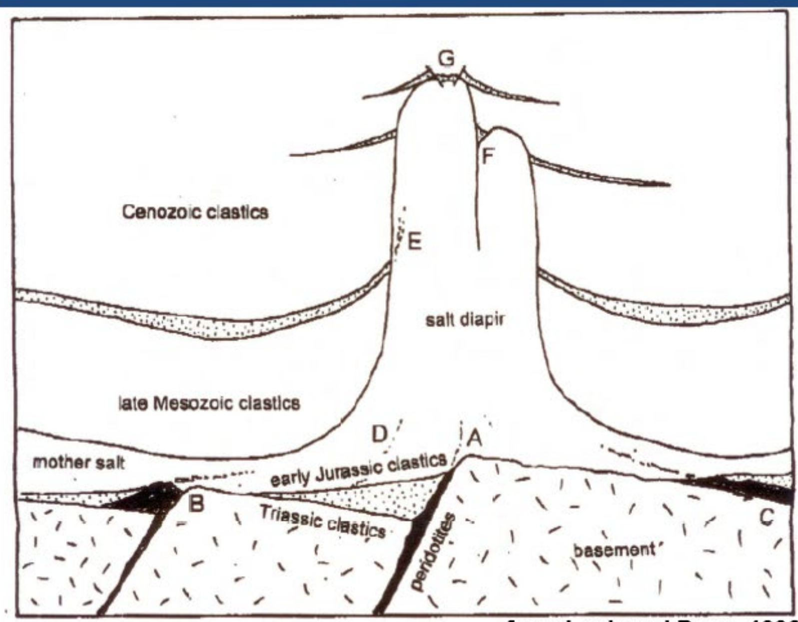


Figure 3. Generalized stratigraphic column of Ochoan rocks at the WIPP site, Eddy County, New Mexico and the cored interval in the ERDA-9 drill hole (Powers and others, 1978).

Salinization/brine Problem

MagmaChem
Research Institute

Origin of Salt – Salt is frequently associated with oil. Saline sedimentary sequences commonly occur in the upper chemo-stratigraphy of many petroleum basins. The Michigan, Paradox, and Permian basins, and the Zechstein basin in northern Europe are only a few examples of hydrothermally related saline deposits. The amount of salines in a given basin presents a major mass balance problem for the conventional models of salt origin by evaporation of sea water. The co-occurrence and co-transport of salines and hydrocarbon-rich brines from UDH deep sources is a more reasonable alternative.



from Lock and Duex, 1996

Figure 5. Diagrammatic representation of the Five Islands salt complex in cross section. Note the basement faults, including one postulated beneath the Five Islands lineament, with ultramafic intrusion (A) exposed to the salt on the fault scarp. Alternative sources of peridotite are from sub-salt extrusions (B) or earlier (Ouachitan) obducted ophiolites (C). If the peridotites are younger (Cretaceous, for example), they may have been intruded through the salt and incorporated then, or may be interbedded with clastic sediments above the salt. Above-salt materials may be picked up by salt from flank beds (E), perhaps initially as part of the overpressured shale sheath (not shown), may be trapped between salt spines as part of a so-called "shear zone" (F), or incorporated at head of the rising diapir (G).

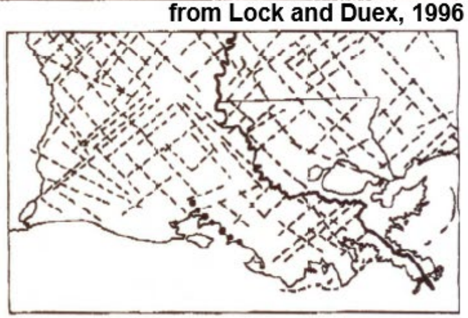


Figure 6. Part of Fisk's (1944) map of Gulf Coast geomorphic lineaments traced from air photographs, with the Five Islands features superimposed. The lineaments may reflect crustal extension faults in the basement, formed during opening of the Gulf of Mexico.

THE SERPENTINITE-STEATITE 'SMOKING GUN' IN REMOBILIZED UPPER JURASSIC LOUANNE SALT DIAPIRS, LOUISIANA

- Lock and Duex (1996), uncovered powerful direct evidence for the UDH process which appears as steatized serpentinite xenoliths in Cenozoic age diapirs of Louanne salt from the Avery and Weeks island salt diapirs.
- The serpentinite xenoliths strongly suggest that the salines in the Louanne salt may have been derived from steatization of an ultramafic serpentinite source.

Salinization/brine Problem

MagmaChem Research Institute

Oil Field Brine Anomaly – Brines (not just water) are universally associated with oil accumulation. Oil field brines are commonly more abundant than the oil itself, and are difficult to discriminate from oil in resistivity logs. The consistent association of brine and oil is not part of the conventional oil model, with is produced from black kerogenous shale sources under anhydrous (dry) conditions. On a volume basis, liquid oil exhibits much lower volumes than the associated brines. The petroleum systems should be more appropriately considered as petroliferous brine systems. Experimental data has shown that by increasing the salinity of associated brines, the amount of oil produced is also increased. Experiments have shown that the temperature of the water is associated with increasing oil solubility, so that when hydrothermal water brine is present, it is an effective transport agent for oil. The association is not accidental. Salines may be a necessary and sufficient condition for, not only the possibility of oil formation, but also the amount of oil formation. In the UDH model, the oil-brine association is considered a necessary part of the process with the hydrogen coming from the water component of the brine as a necessary part of the process. The hydrogen from the water hydrogenates the hydrogen-poor polyaromatic-dominated kerogen into alkane-dominated hydrogenated liquid oil. Indeed,, oil accumulations can and should be regarded as smaller-scale components of typically much larger brine systems that are ultimately causal to oil formation.

Lithium enriched brine from oil sands in Peace River Arch, Alberta

Role of water in petroleum formation 3707

Table 11. Experimental conditions and expelled product (expelled oil and gas) yields of hydrous pyrolysis experiments with various water chemistries.

Condition Experiment	Water/rock ratio 0.8 10	Water/rock ratio 0.8 11	Water/rock ratio 2.25 12	0.1 N HCl hydrous 16	H_2-pressured hydrous 17	5 wt% NaCl hydrous 15
Temperature (°C)	330.0	329.7	329.9	329.5	327.6	329.79
Duration at temperature (h)	70.70	70.70	70.85	70.70	70.70	70.55
Initial pH	5.65[a]	5.65[a]	5.65[a]	1.00	5.65[a]	5.65[a]
Final pH	6.61	6.58	6.21	4.68	6.70	6.00
Expelled oil (wt% rock)	2.66	2.69	2.75	2.61	2.53	3.80
Gas (wt% rock)	1.55	1.40	1.29	1.36	1.27	1.53
Total expelled product (wt% rock)	4.21	4.09	4.04	3.97	3.80	5.33
Gas composition (mmol/400 g rock)						
Methane	49.34	48.51	36.24	45.87	39.97	52.38
Ethane	32.62	30.91	25.27	30.63	29.79	34.36
Propane	12.23	11.74	10.20	11.40	10.17	12.46
i-butane	1.85	1.77	1.89	1.43	1.03	0.90
n-butane	3.44	3.39	3.97	3.79	3.51	4.30
Pentanes	1.12	1.14	1.68	1.76	1.62	1.88
C_6+	0.00	0.14	0.37	0.07	0.00	0.00
Ethene	0.00	0.58	0.05	0.00	0.00	0.00
Propene	0.00	0.00	0.32	0.00	0.02	0.00
Butenes	0.00	0.00	0.03	0.00	0.00	0.00
Pentenes[b]	0.55	0.35	0.53	0.37	0.37	0.62
Hexenes[b]	0.00	0.00	0.35	0.16	0.27	0.00
Butadienes	0.00	0.07	0.05	0.07	0.08	0.00
CO_2	48.67	40.86	39.68	39.74	32.75	44.66
CO	0.97	0.00	0.00	0.61	0.58	0.00
H_2	4.32	6.25	11.32	6.53	49.93	7.94
H_2S	37.78	32.56	29.61	30.10	34.36	36.48
NH_3	0.50	0.00	0.64	0.45	0.65	0.18

[a] Values assume deionized (ASTM Type-1) water is in equilibrium with atmospheric CO_2 according to calculations by Butler (1982).
[b] Alkenes plus cyclic alkanes.

Salinization/brine Problem

Huge Masses of Brines/Salines – How much sea water was required to evaporate that much salt? The massive amount of salines in a given basin presents a huge anomaly for a simple evaporation model. For example, the Silurian salt in the Michigan Basin requires approximately 80 oceanic water columns to evaporate to accumulate the amount of salt mass present. It is now known that serpentinite is a major reservoir for chlorine, which can be combined with nearby sodium-rich brine sources to make saline-rich brine plumes that easily can solve the mass balance problem.

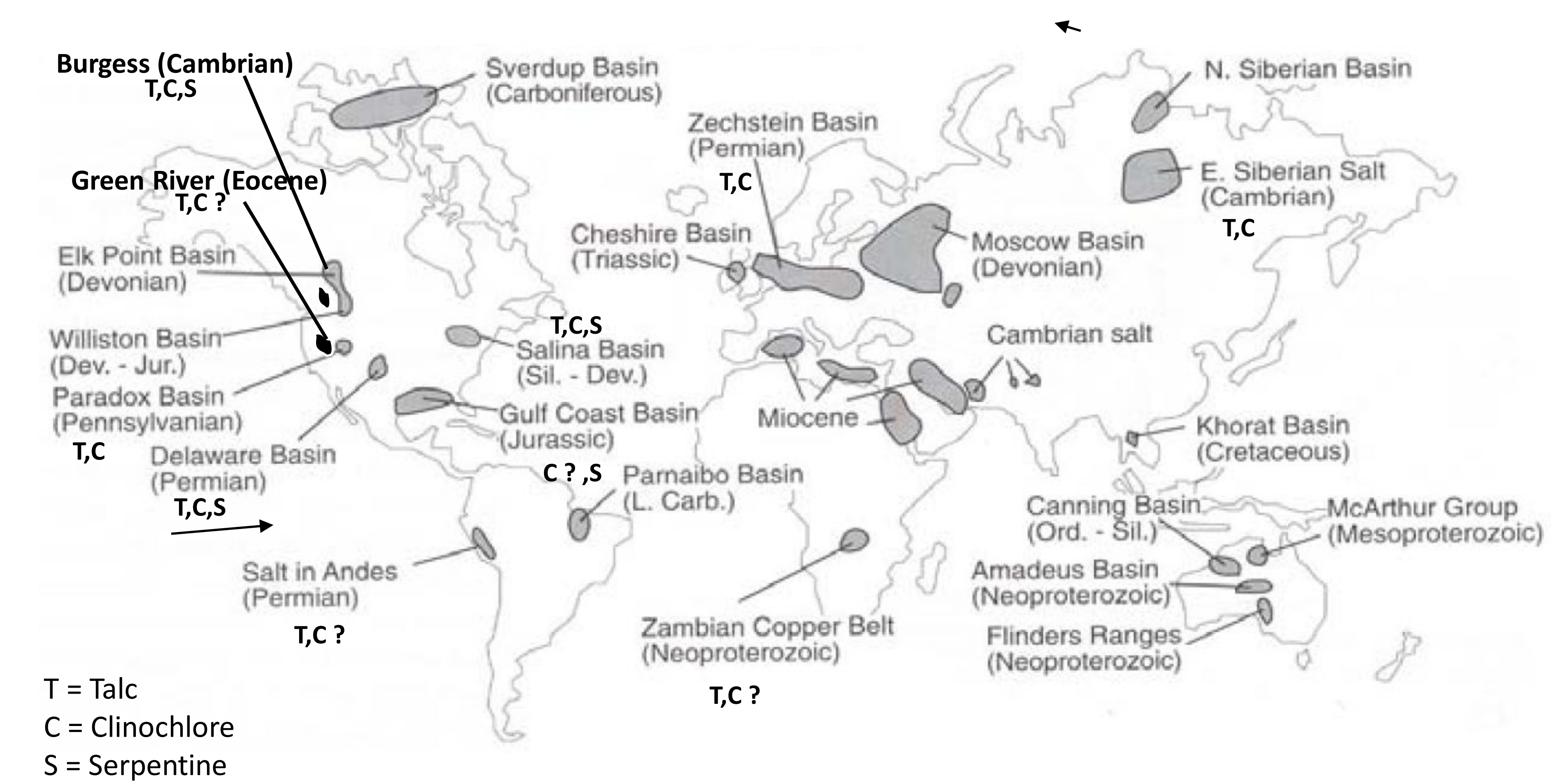


Fig.4. Map showing location and age of some of major basinwide evaporite deposits (after Kendall 1992). The presence of serpentinite related minerals (talc, etc) is of UDH interest.

Salinization/brine Problem

MagmaChem Research Institute

Magnetite in Oil and Salt – Many sludge tanks in a given oil field contain magnetite. The magnetite is commonly spherical in shape. In some cases, the magnetite forms concentric layers between the salt, which effectively produces an oolitic texture. Magnetite formation temperatures are typically at greater than 400˚C, indicating that the magnetite-bearing brines experience high energy conditions. The spherical oolitic texture can be interpreted to indicate an equilibrium texture formed in liquid state, such as those associated with high-temperature brine flowage. Spherical magnetite is known from the oil-related salt magnetite pipes of the Tunguska basin in western Siberia, in several Chinese oil fields, and in several mid-continent oil fields in North America. Hematite pisoliths in Clinton-type iron deposits may have a similar brine origin.

Ooidal Magnetite spheres floating in salt/halite matrix, Tunguska Region Irkutsk Oblast, Russia (source: mindat.org) Found in a breccia pipe at the **Korshunovskoye iron deposit**

Salinization/brine Problem

MagmaChem Research Institute

Talc in Salt – Like magnetite, talc is anomalously found in numerous salt basins that coexist with oil. Examples are the Permian basin, Tunguska basin, and Zechstein basin. The coexistence of talc, salines (mainly halite), and locally hydrocarbons indicates a high-temperature (greater than 300˚C origin for these compounds, as well as a magnesium-rich source, such as serpentinite. Talc, dolomite, and serpentinite are common associates in upper greenschist to lower amphibolite basement rocks. In the UDH model, such minerals may have formed as precipitates from brine flowage through the basement to high level depositional sites in the overlying basins. Like magnetite ooids, talc ooids, as well as stevensite ooids, are known in saline sequences (e.g. in Green River, Wyoming, the Great Salt Lake in Utah, and in ancient saline deposits in central Africa)

THE TALC-QUARTZ SMOKING GUN: ZECHSTEIN-GORLEBEN SALT DIAPIR

FIG. 1.—Location of the Gorleben salt dome in northern Germany.

Zechstein units: Zechstein 7 (Mölln-Folge); Zechstein 6 (Friesland-Folge); Zechstein 5 (Ohre-Folge); Zechstein 4 (Aller-Folge); Zechstein 3 (Leine-Folge); Zechstein 2 (Staßfurt-Folge); Zechstein 1 (Werra-Folge)

Leine-Steinsalz

Hauptanhydrit z3HA

Kosmahl (1969)	Bornemann (1991)	
Zone A3 omega	z3HA13	"Anhydritschale"
Zone A3 t	z3HA12	Schwarzes Tonbänkchen (black clay layer)
Zone A3 lambda	z3HA11	**Bänderanhydrit (banded anhydrite)**
Zone A3 kappa	z3HA10	Maseranhydrit (veined anhydrite)
Zone A3 jota	z3HA9	Flaser-, Bänderanhydrit (flaser and banded anhydrite)
Zone A3 theta	z3HA8	Bündelanhydrit (bundle anhydrite)
Zone 3A eta	z3HA7	Lamellenanhydrit 3 (lamellar anhydrite 3)
Zone A3 zeta	z3HA6	Lagenanhydrit (layered anhydrite)
Zone A3 epsilon	z3HA5	Schlierenanhydrit (streaked anhydrite)
Zone A3 delta	z3HA4	Flaseranhydrit (flaser anhydrite)
Zone A3 gamma	z3HA3	Lamellenanhydrit 2 (lamellar anhydrite 2)
Zone A3 beta	z3HA2	Flocken-, Flaseranhydrit (flaked and flaser anhydrite)
Zone A3 alpha	z3HA1	Lamellenanhydrit 1 (lamellar anhydrite 1)

Leine-Karbonat

Grauer Salzton

FIG. 3.—Stratigraphy of the Hauptanhydrit (z3HA), after Kosmahl (1969) and Bornemann (1991).

- Talc-bearing stylolite zones are common in the Zechstein 3 anhydrite-magnesite units in the Gorleben salt diapir in northern Germany.

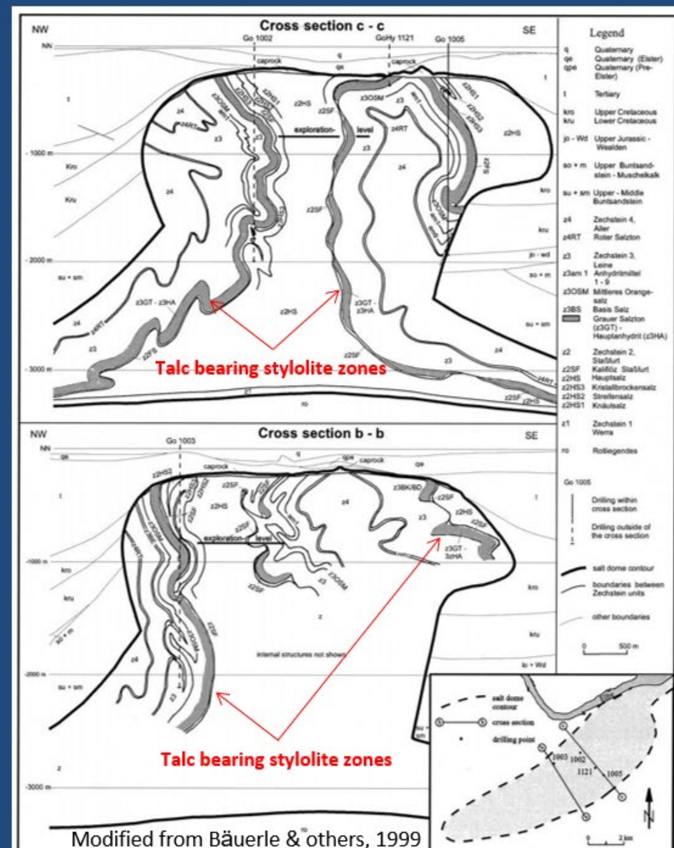
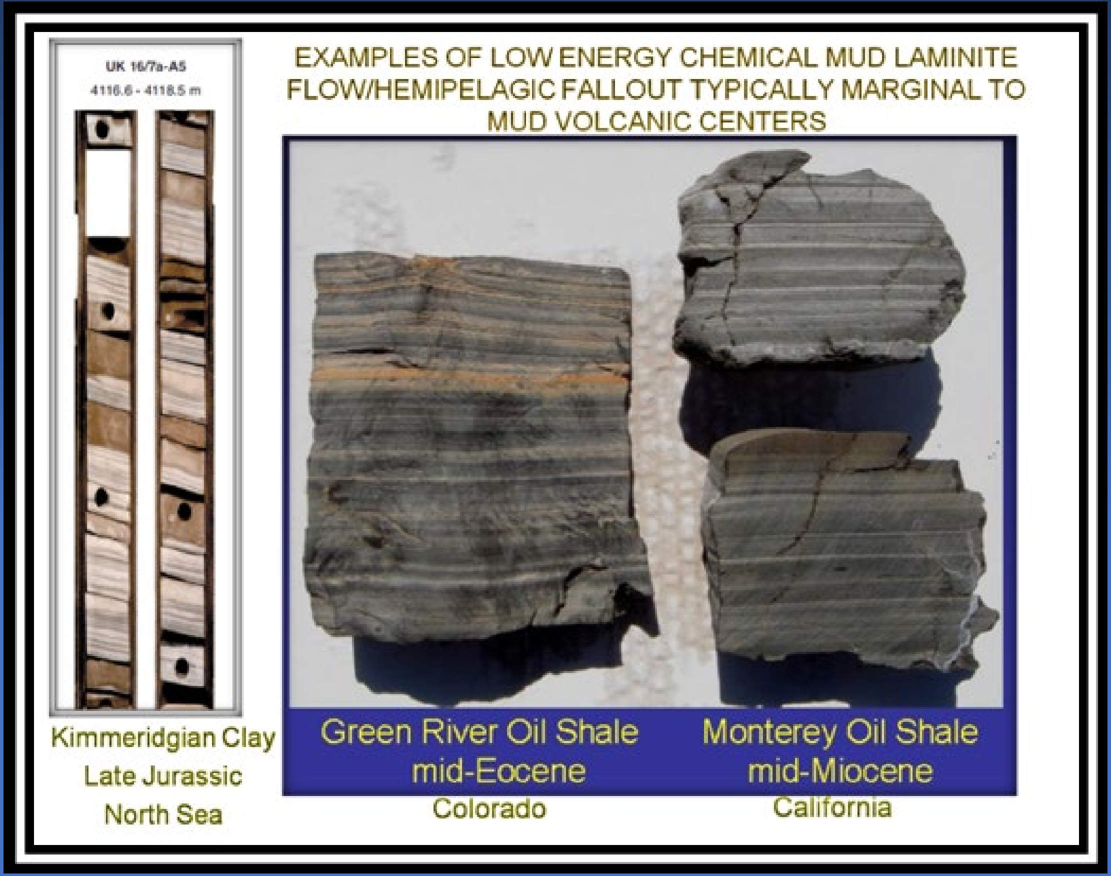


FIG. 2.—Two cross sections through the Gorleben salt dome with Hauptanhydrit (shaded) and positions of the studied core intervals. Inset shows contour of the diapir with well and shaft locations and position of the two cross sections (after Bornemann 1991).

Mud Volcanism Issue

MagmaChem Research Institute

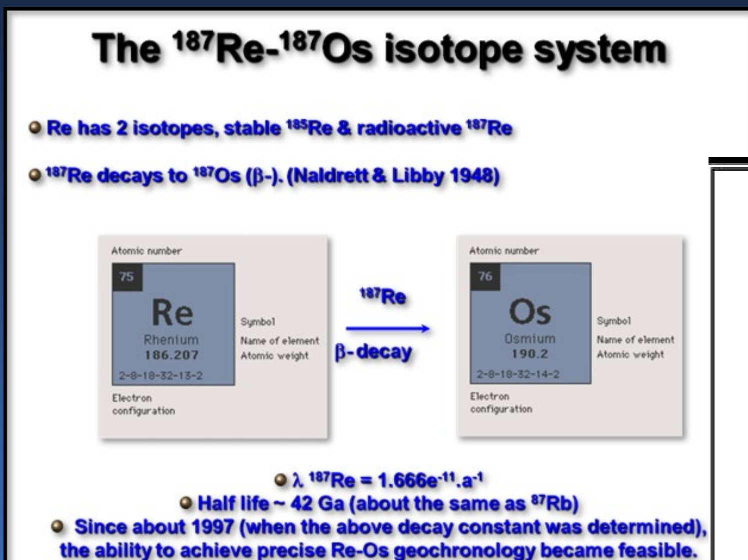
Fast Facies Changes – Improbably rapid, transgression/regression or sea level rise and fall is used to explain alternating environments of shallow ocean, shelf carbonates to anoxic, deep basin muds, also called ‘elevator tectonics’. One well known example includes juxtaposition of low temperature and high temperature silica facies (opal CT) in the Monterey Shale of coastal California. Another example is the fluctuating, deep to shallow facies of presumed deep-water carbonaceous shales to shallow water, trona-'evaporite' facies in the Green River Lake system of the central Rocky Mountains. In the UDH model the apparent juxtapositions do not represent rapidly changing depths. Rather, rapid compositional changes represent differing chemical fractionations from a brine that produces chemically stratified mud facies at the same general depth based on density, temperatures, and chemical contrasts. These materials in a chemically zoned mud chamber then are periodically emptied or ‘erupted’ and then the material is replenished by new brine mud, which undergoes the same density-temperature sorting to make new chemical muds. This results in a cyclothemic sorting at numerous scales and repititions during the lifetime of a given mud volcanic process.

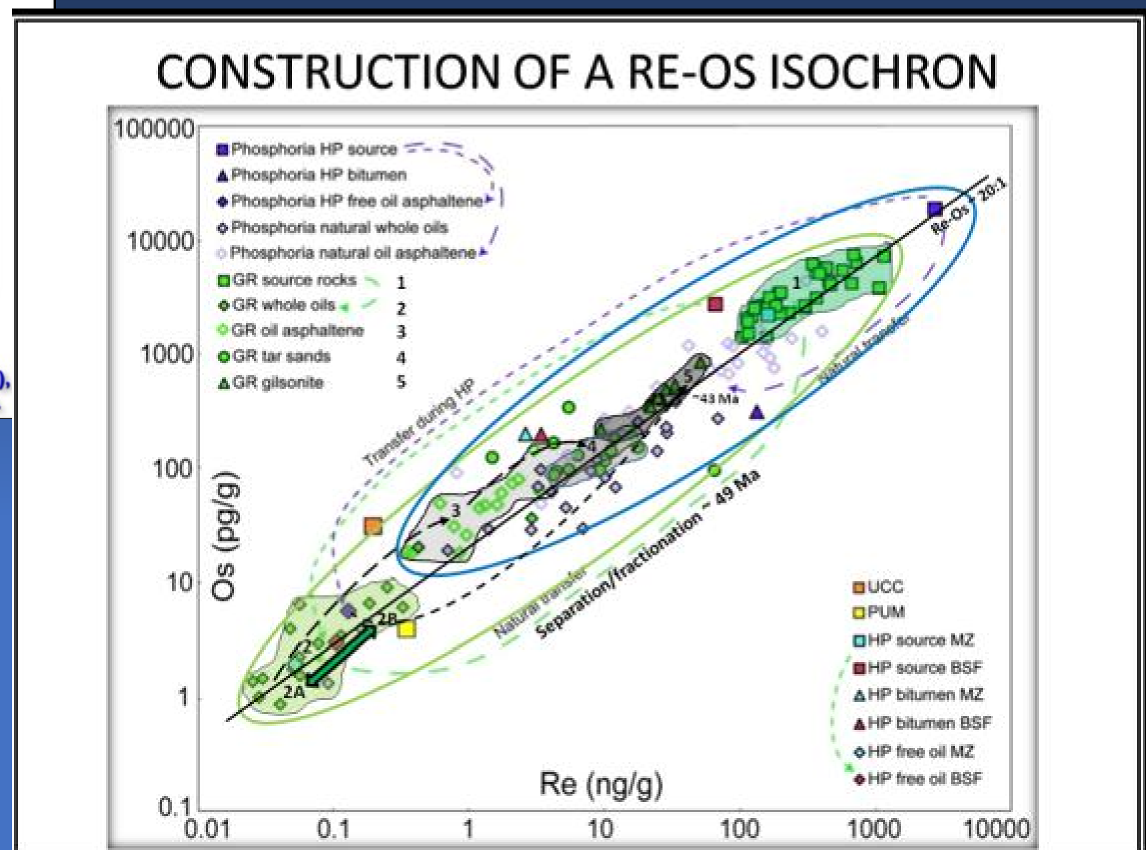


Mud Volcanism Issue

MagmaChem
Research Institute

Contemporaneous Age of Oil and Hosting Reservoir Anomaly – The co-val age by Re-Os dating of reservoir formation and of the kerogen and oil present in the reservoir has now been established for more than 40 case histories around the world, beginning with the supergiant Athabasca heavy oil sand deposits. All of these data are highly anomalous to the formation of oil model by diagenetic basin burial and in fact may falsify it. The contemporaneous formation of oil and its host rock is entirely predicted by the UDH model. Contemporaneous formation of oil from kerogenous source rocks under hydrothermal conditions has also been validated experimentally.





Mud Volcanism Issue

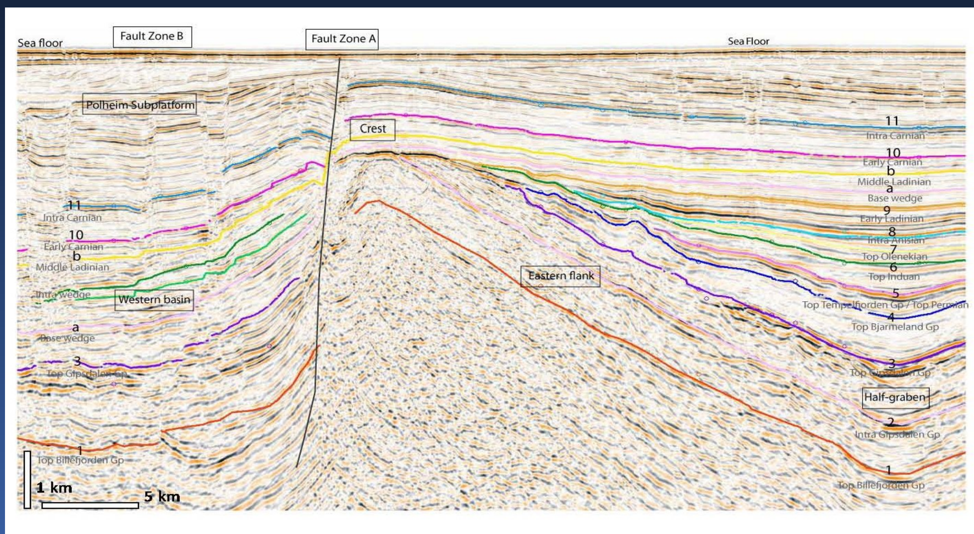
MagmaChem
Research Institute

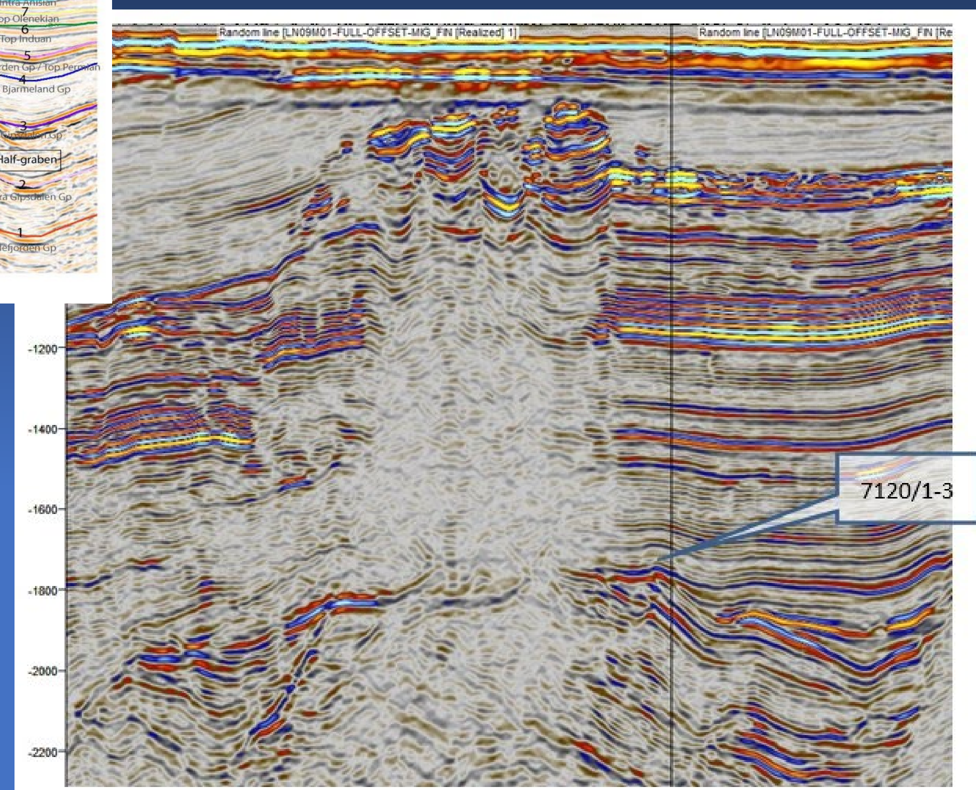
Mud Volcanism Anomaly – Mud volcanism is routinely associated with oil and brine accumulations, as well as with saline deposits. The petroleum community typically interprets the containing sedimentary section from a classical surface sedimentology point of view. Any mud volcanic interpretation is usually absent. In the UDH model, mud volcanism is a necessary part of the petroleum making process. The muds are delivered by density separation and precipitation of chemical mud-size particulates from high-density, deep-sourced brines. The main chemical components are magnesium, silica, carbonate, and minor alumina, which ultimately are deposited as the so-called authigenic mineral suite (dolomite, calcite, quartz, and clay) in a given reservoir. The deep-sourced muds are present as mud volcanoes when they are extruded onto the surface where, like any other sedimentary rock, they must obey the laws of sedimentology. In the subsurface, the mud brines solidify as injectite dikes and sills that show on seismic sections as reflecting horizons like many other sedimentary rocks. Mud vulcanism is becoming increasingly well recognized and can now be regarded as an important part of the sedimentational process on a global scale. The association of mud volanism and its associated brine and petroleum deposite, injectites, and salines is still underappeciated and provides very fertile ground for future investigation.

Mud Volcanism Issue

MagmaChem
Research Institute

Seismic Turbidity Anomalies – Mud conduits commonly appear as turbidity anomalies in seismic sections where they are commonly mistinterpreted as seismic noise or processing problems. In fact, these seismic anomalies may not be a processing problem, but rather should be regarded as a real indication of a potential mud diapir. Oil accumulations are frequently found near and adjacent to the diapirs and may fill porosity in associated injectite sills, especially silica injectite sills.

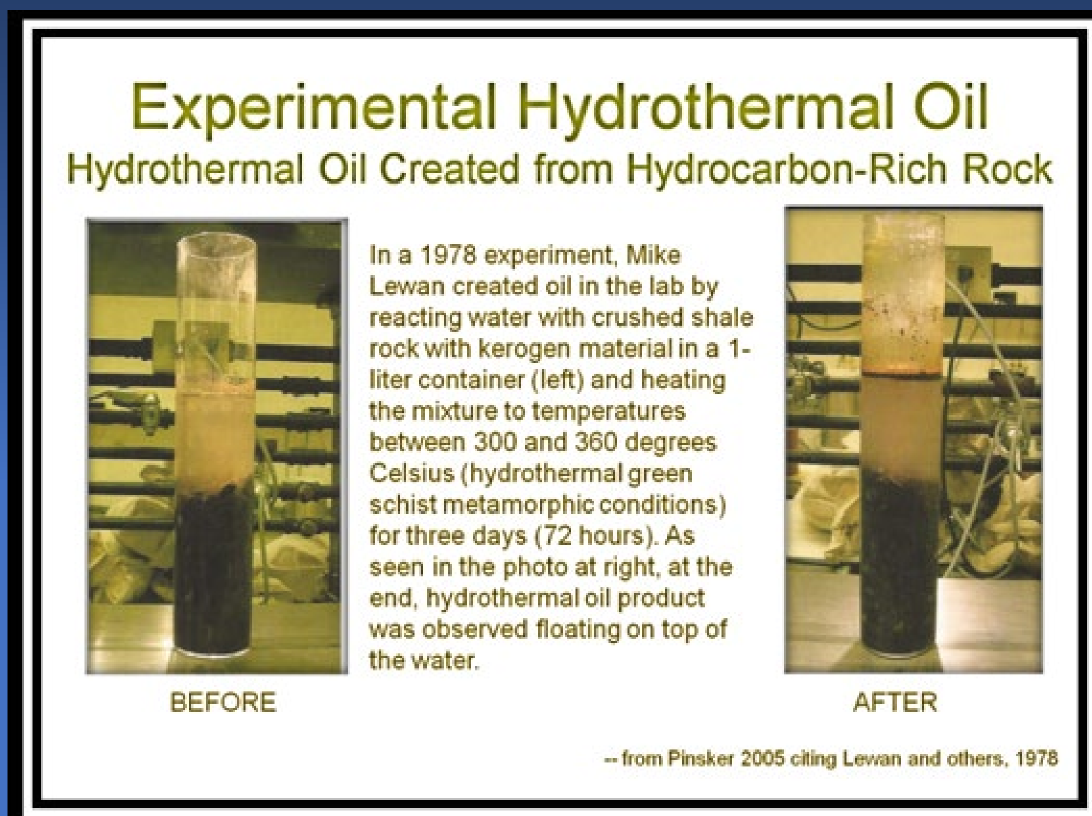




Oil Problem

MagmaChem Research Institute

Hydrothermal Oil Experimental Anomaly – In 1997, Michael Lewan reported the results of hydrous pyrolysis experiments on numerous kerogen-rich shales that created oil in 72 hours at high temperature between 310˚ and 275˚C in the presence of water. In notable anomalous contrast, dry pyrolysis (similar to the basin burial, dry heating model) on the same material only created hydrocarbon gases. Oil was anomalously formed at about three times the conventional, dry pyrolysis window (about 70˚ to 135˚C from simple dry heating of crude oils) for oil formation under hydrothermal conditions. The high temperatures/energy for oil formation (310-375˚C) identified in the Lewan hydrothermal oil experiments are highly anomalous to the conventional model and potentially expand the oil generation process into higher energy environment. In this context, the oil window is expanded to the 400˚C geotherm, which is the upper limit on oil/diamondoid formation and to perhaps 20 km into the middle crust. The conventional oil window thermally only extends to some 6 km in the upper crust. The expanded oil window offers many additional geologic environments within which oil can occur.



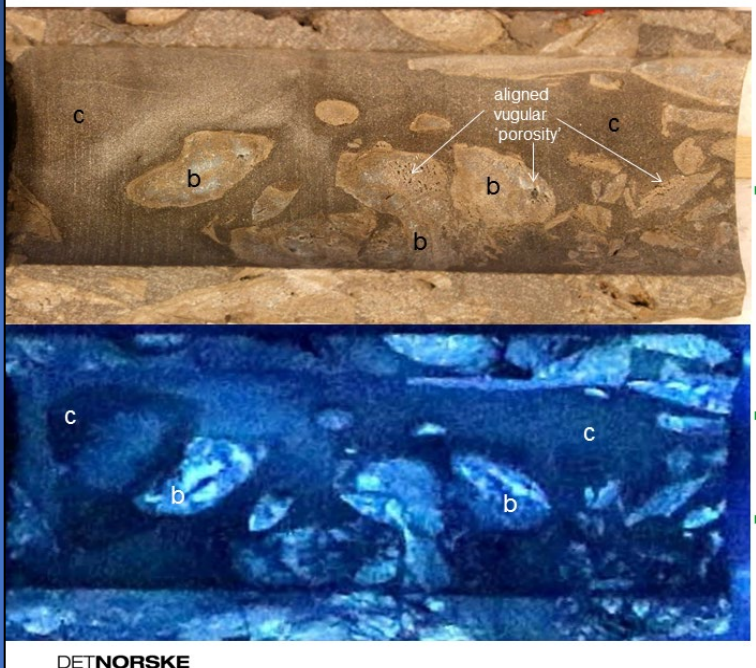
Oil Problem

MagmaChem Research Institute

Migration Pathway Problem – One of the persistent problems as related to Keith by a former Mobile Oil petroleum researcher concerns oil migration. While the source rock part of the oil system model had been solved as kerogenous black shales and the trap portion had been solved as obvious reservoirs, the migration part remains unsolved. No one has observed an oil slick migration path from source to trap.

For the UDH model, this problem is solved by the observation that because oil is a small component of a much larger hydrothermal brine system, the strong suggestion is that oil origin is not about an oil slick migration trail; rather it is about a hydrothermal brine alteration trail. The huge, regional-scale, potassium metasomatism in the Hudsonian - Early Proterozoic basement beneath the oil sands or the 60-mile long, hydrogen bleached 'sandstone' silica injectite dike swarm in the Colorado Front Ranges that projects beneath the petroleum systems hosted in the Niobrara Formation are examples of a hydrothermal brine alteration trail. Other examples are large regional clusters of serpentinite, carbonaceous black meta-shale, talc and dolomite dikes and lenses in basements beneath petroleum deposits areas in northwestern New York (the Adirondacks), southwestern Montana (in the Dillon region), or in the Norwegian Caledonide basement along regional strike with the North Sea petroleum cluster.

These examples all represent potential sources of brine or products of magnesium-kerogen-carbonate-rich brine migration in crystalline basements that are spatially associated with petroleum deposits in overlying Mesozoic and Cenozoic sedimentary sections. These sedimentary rocks need to be re-evaluated for mud volcanic facies. In the UDH model, these hydrothermalite rocks have become known as UDH complexes and typically represent hydrous metasomatites that have been superimposed as cross-cutting dikes and protrusions on earlier metamorphic rocks. A UDH complex serves as a metasomatic rock connector between the deep serpentinite 'kitchen' and the petroleum systems housed in sedimentary basins in the upper crust.



a - opaline silica

b – porous dolomitic silica injectite

c - siliceous dolomite injectite

- The adjacent photos show the clear two phase nature of the two reservoir injectites and the more vugular and fluoresent nature of the early siliceous injectite which strongly indicates that oil formation accompanied the emplacement of the early injectite.
- The texture compellingly demonstrates that oil formed during the formation of the reservoir and did not migrate into it after its formation.
- The oil occupies an aligned 'flow' porosity that resembles a 'depressurization' effervescence that may reflect unmixing of S1 bitumen into liquid state oil from parent kerogens in the 'pore' space

Oil Problem

MagmaChem Research Institute

Rock-Eval Anomalies – Rock-eval data indicate high temperatures that are far above the conventional oil window. Since its discovery by Alexander Crum Brown in the early 1900s, rock kerogen has been found to display thermal features that indicate formational conditions way above the conventional oil window. Heated kerogen devolatilizes in to hydrocarbon components in a seqenced manner. Under dry heating conditions, the labile oil component is liberated at temperatures of about 250˚C, whereas the more refractory gas component is released at temperatures of about 450˚C. Carbon dioxide gas is driven off at even higher temperatures circa 600˚C. From the UDH perspective, the high temperatures of petroleum formation indicate the formational temperatures of the labile bitumen component liberated at the S1 temperature step, whereas S2 gas-dominated species represent hydrocarbon gas leftovers remaining in what amounts to a refractory hydrocarbon slag. In this sense, the S1 term may have more generation significance than S2, which is erroneously interpreted as generation potential.

	Sample/ depth	Kerogen (TOC) wt. %	CO2 wt. %	S1	S2	S3	Tmax	Hydrogen Index S2(100)/TOC	Oxygen Index S3/TOC	S2/S3	S1/TOC Normalized Oil Index	Production Index S1/S1+S2
ILLITIC SHALE HYDROGENATION SEQUENCE	7120/1-3-2180	1.96	8.34	0.31	3.61	6.54	445	184	334	0.55	16	0.08
	7120/1-3-2186	1.97	11.2	0.26	3.70	8.85	450	188	449	0.42	13	0.07
	7120/1-3-2216	0.9	3.84	0.56	2.19	4.38	438	243	487	0.50	62	0.20
	7120/1-3-2219 WD	1.23	3.36	7.44	3.61	2.97	437	293	241.46	1.22	604.88	0.67
	7120/1-3-2231 WD	0.94	3.81	5.15	2.81	2.26	437	299	240.43	1.24	547.87	0.65
	7120/1-3-2240 WD	0.96	4.35	3.54	2.71	2.29	435	282	238.54	1.18	368.75	0.57
	7120/1-3-2249 WD	0.71	6.54	3.08	2.02	2.36	429	285	332.39	0.86	433.80	0.60
	7120/1-3-2270 WD	0.99	4.52	2.63	2.54	2.09	429	257	211.11	1.22	265.66	0.51
	7120/1-3-2279 WD	0.72	5.65	1.79	1.73	1.62	423	240	225.00	1.07	248.61	0.51
	7120/1-3-2291 WD	0.69	6	2.42	1.6	1.47	376	232	213.04	1.09	350.72	0.60
INJECTITE RESERVOIR	7120/1-3-2300 WD	0.025	31	0.37	0.18	0.57	0	360	1140.00	0.32	740.00	0.67
	7120/1-3-2309 WD	0.49	38.9	0.06	0.05	0.26	0	10	53.06	0.19	12.24	0.55
	7120/1-3-2321 WD	0.15	36	0.15	0.12	0.32	0	80	213.33	0.38	100.00	0.56
	7120/1-3-2330 WD	0.66	33.2	0.5	0.29	0.7	415	44	106.06	0.41	75.76	0.63
	7120/1-3-2351 WD	0.48	37.1	0.21	0.2	0.25	0	42	52.08	0.80	43.75	0.51
	7120/1-3-2360 WD	0.28	15.7	0.51	0.17	0.43	0	61	153.57	0.40	182.14	0.75
	7120/1-3-2369 WD	0.22	11.9	0.57	0.12	0.4	0	55	181.82	0.30	259.09	0.83

Biosphere Issue

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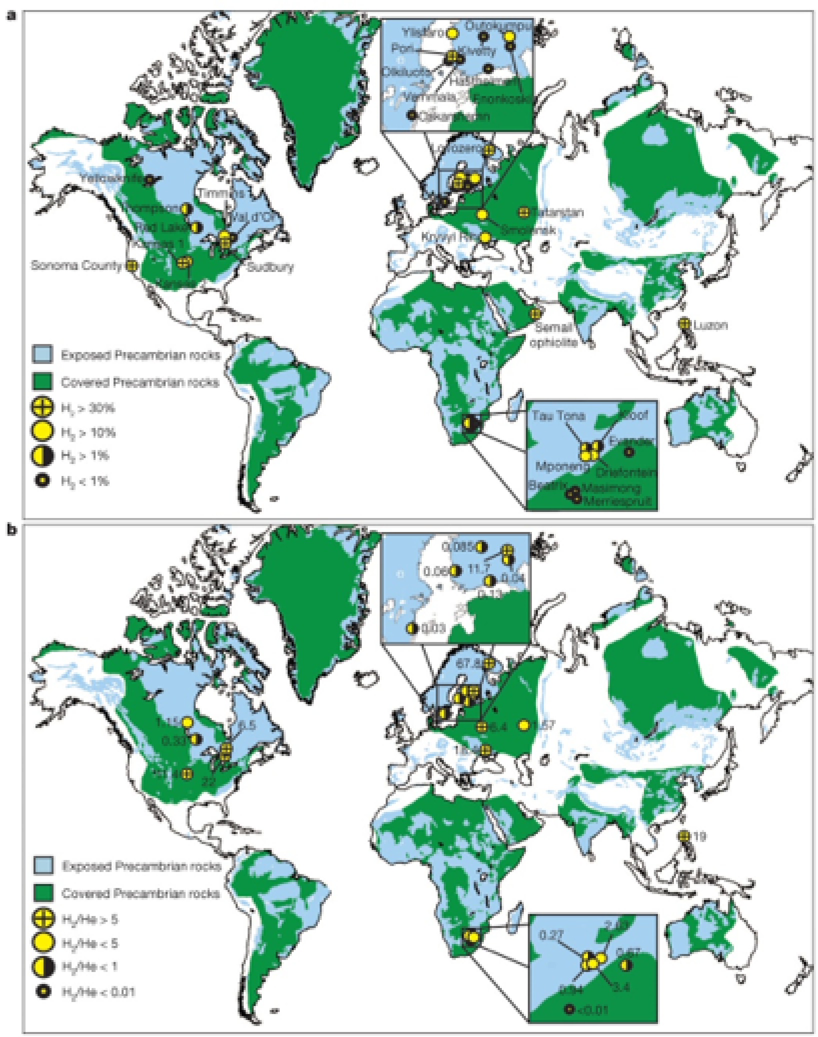

Figure 1 | Precambrian rocks of the continental crust. Geologic data are from ref. 12. Total Precambrian crust, exposed (blue) and buried (green), accounts for 1.06×10^8 km^2, or >70% of total continental crust surface area[12]. Symbols for each site show the highest reported H_2 levels in volume per cent (**a**) and H_2/He ratios (**b**), with locations provided in Table 1. H_2 concentrations and H_2/He ratios listed are the maximum observed at each location, but represent a minimum estimate owing to simultaneous H_2 consumption both by microbial communities of sulphate-reducers and methanogens[1] and reaction of H_2 to produce abiogenic hydrocarbons via Fischer–Tropsch synthesis[21,28]. Map generated via open source software from ref. 29.

Figure 58. Distribution of planetary hydrogen gas emissions (Sherwood-Lollar and others, 2014)

Biospheric Mass Balance Problem (the 'dead dinosaur' problem) – There is not enough dead biomass to convert to the massive amounts of oil. Two major problems exist with the biospheric source for oil: 1) There is not enough biospheric mass to make oil; and 2) It is very difficult to make oil from the biospheric material available. Much of the biospheric material is consumed by other biologic entities. To paraphrase Joseph Campbell, 'it is the great irony of life, that to exist, life must eat other life'.

Biosphere Issue

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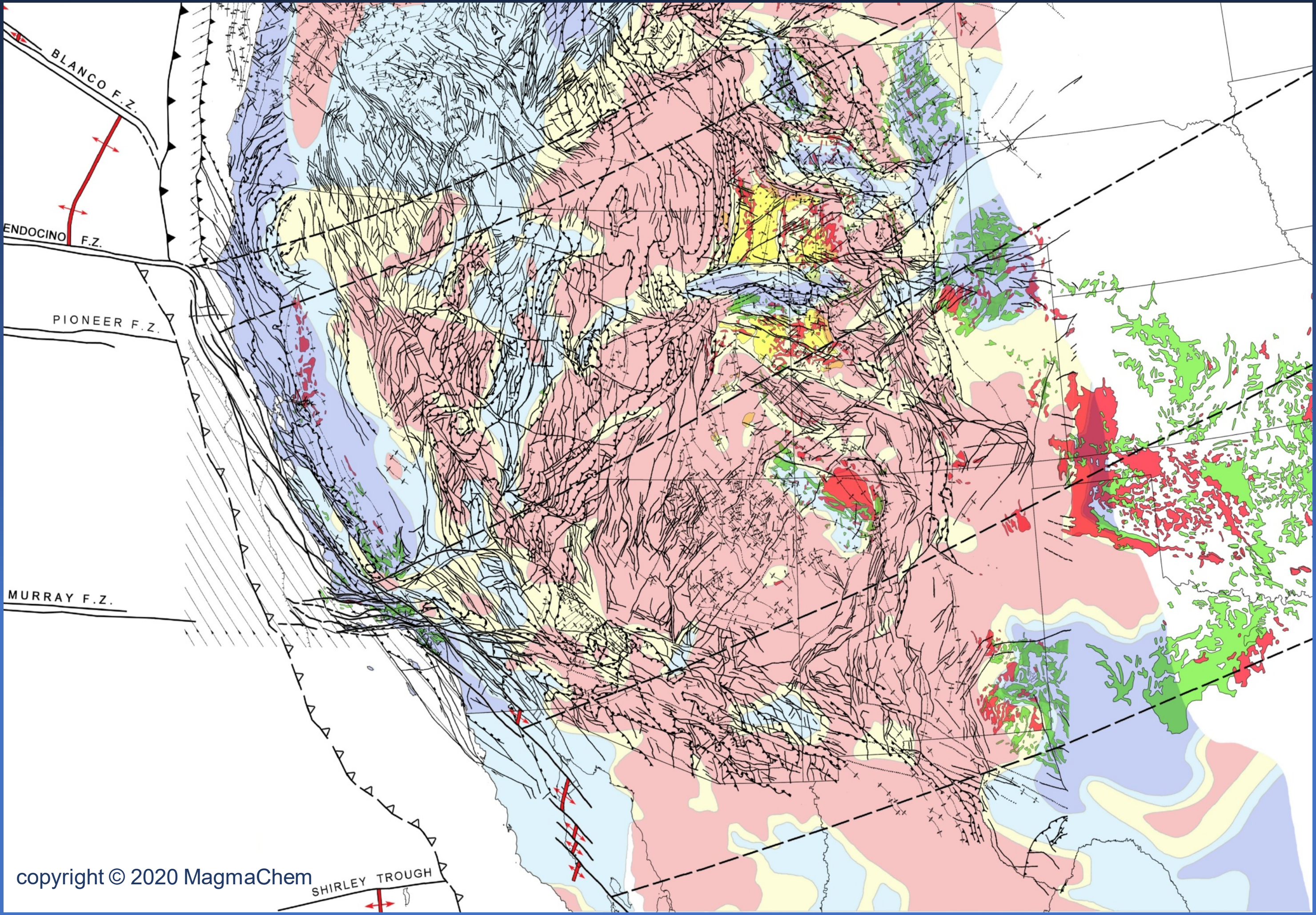
Oxidation State Anomalies – The high oxidation state of biomass is also difficult to explain in the context of the extremely reduced state of oil. Biological systems are C-O-H systems, whereas hydrocarbon systems are C-H systems. The problem is to eliminate the oxygen during the reaction to generally oxygen-absent oil product. In the UDH system, oil is created under reduced conditions that persist throughout the process whereby water distributes its hydrogen to kerogen and contributes its oxygen to carbonates, such as hydrothermal calcite and dolomite, silica, and clays. There is no oxygen-rich reactant problem.



Biosphere Issue

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Kerogen Chemical Mass Balance Anomaly – Kerogen by itself is hydrogen-poor (HC to $H_{0.5}C$) and the ability to make oil (H_2C) from kerogen is limited by the availability of hydrogen. Any production of oil from kerogen rapidly consumes any available hydrogen and the process is quickly halted by hydrogen depletion. For example, two moles of HC kerogen are required to make one mole of H_2C oil, whereas only one mole of HC is required to make one mole of HC in the presence of water (H_2O). The UDH process has essentially an unlimited supply of hydrogen provided by the water during its chemical reaction with kerogen under high temperature, ionic, hydrothermal conditions. In the UDH process, the amount of oil production is limited by the amount of carbon. The presence of other dissolved carbon species resident in seawater, such as bicarbonate in the brine, alleviates any carbon mass balance problem. The conversion of the oxygen component in the water to carbonate (carbon is commonly present in excess) explains the presence of ubiquitous carbonate in many reservoirs.

The three previous anomalies are related. To make oil from biomass, one must first eliminate the oxygen to make kerogen. Then one has to find hydrogen to hydrogenate the kerogen into oil without cannibalizing the kerogen.

These smaller scale anomalies, while explanatory frameworks have provided for individual knowledge specialties, falsify the conventional oil model. The broader UDH paradigm integrates the smaller-scale conceptual compartments into an explanation for all the anomalies. The UDH paradigm also explains major, specific, ‘black swan’ anomalies in a number of epistemological categories (for example, the occurrence of crystallized talc in saline deposits and the co-formation of petroleum and its host rocks). In this context, the well-known aphorism: 'Science consists of islands of conformity surrounded by oceans of ignorance,' is entirely appropriate. We trust that readers of this document will be encouraged by what are considered to be preliminary results that are backed up by considerable empirical, validational force.

Perhaps the biggest misimpression about oil is the nature of oil itself, which is continuously being miscast as a nonrenewable resource with finite physical limits. Ultimately, oil is not a fossil fuel. According to the UDH model, oil is not made from fossils, nor is it a fossil process. It is not a product of fossilized life and it is not a fossil (ancient) process that made oil and continues to make oil. The giant gas deposits in Guaquil in Ecuador, the Brea tar lakes in Trinidad, the tar seeps in the Santa Barbara Channel, and the Carpenteria tar volcanoes continuously erupt.

The long-standing notion that oil is a fossil fuel is false. Like other renewable resources like wind and solar, oil should also be viewed as a renewable resource. We are not running out of oil; only imagination. UDH offers an entirely new paradigm within which to evaluate petroleum formation and occurrence and indeed how the entire earth functions in the broader context of Magma-Metal series and serpentine Hydrocarbon-Metal series.

Biosphere Issue

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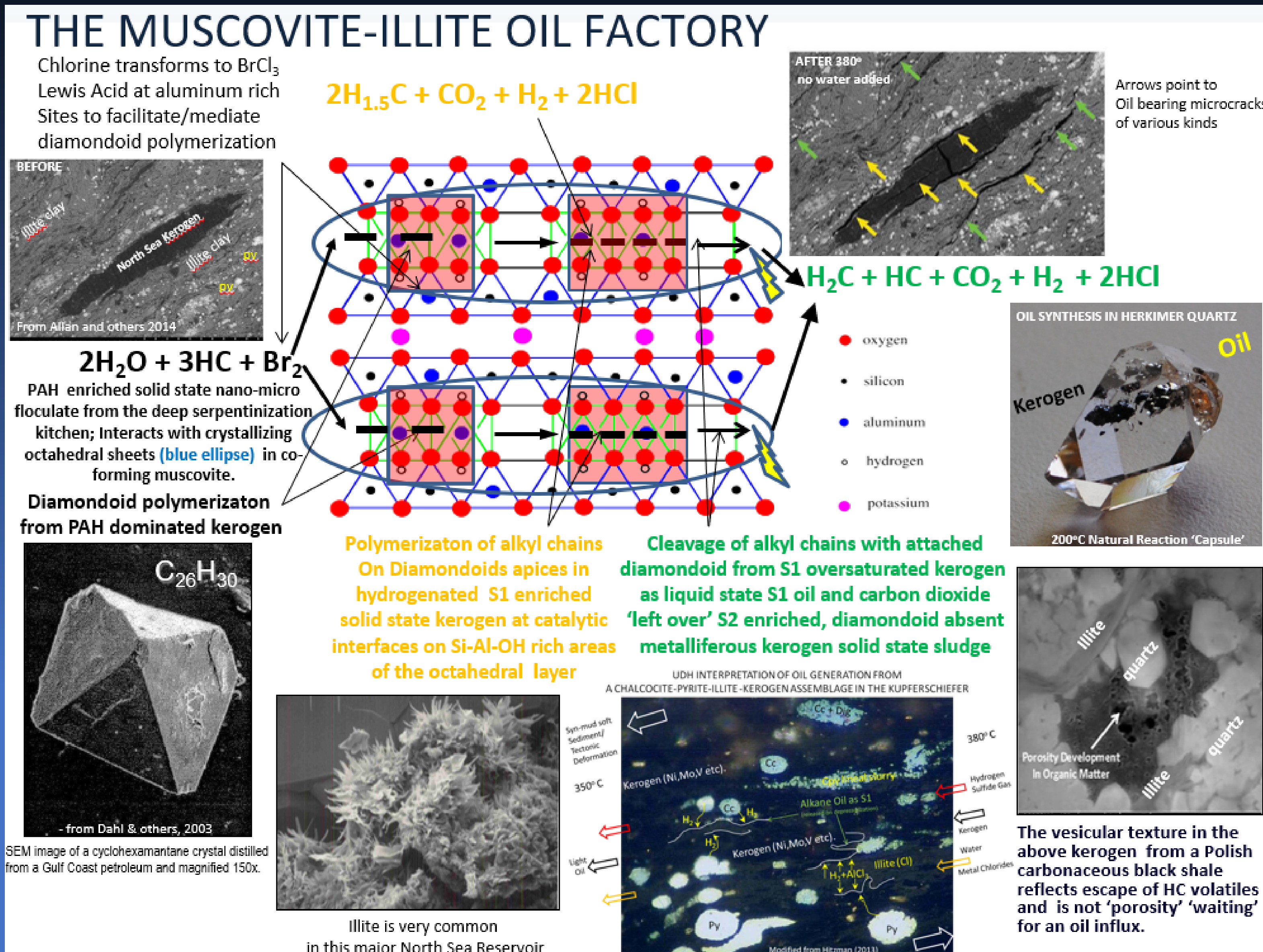
Kerogen Chemical Mass Balance Anomaly –



Anomalies and Problems for Conventional Petroleum Model

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- Kerogen Anomalies
- High Energy Mineral and Rock Anomalies
- Black Shale Problem
- Salinization/brine Problem
- Mud Volcanism Issue
- Oil Problems
- Biosphere Issue

Anomalies and Problems for Conventional Petroleum Model

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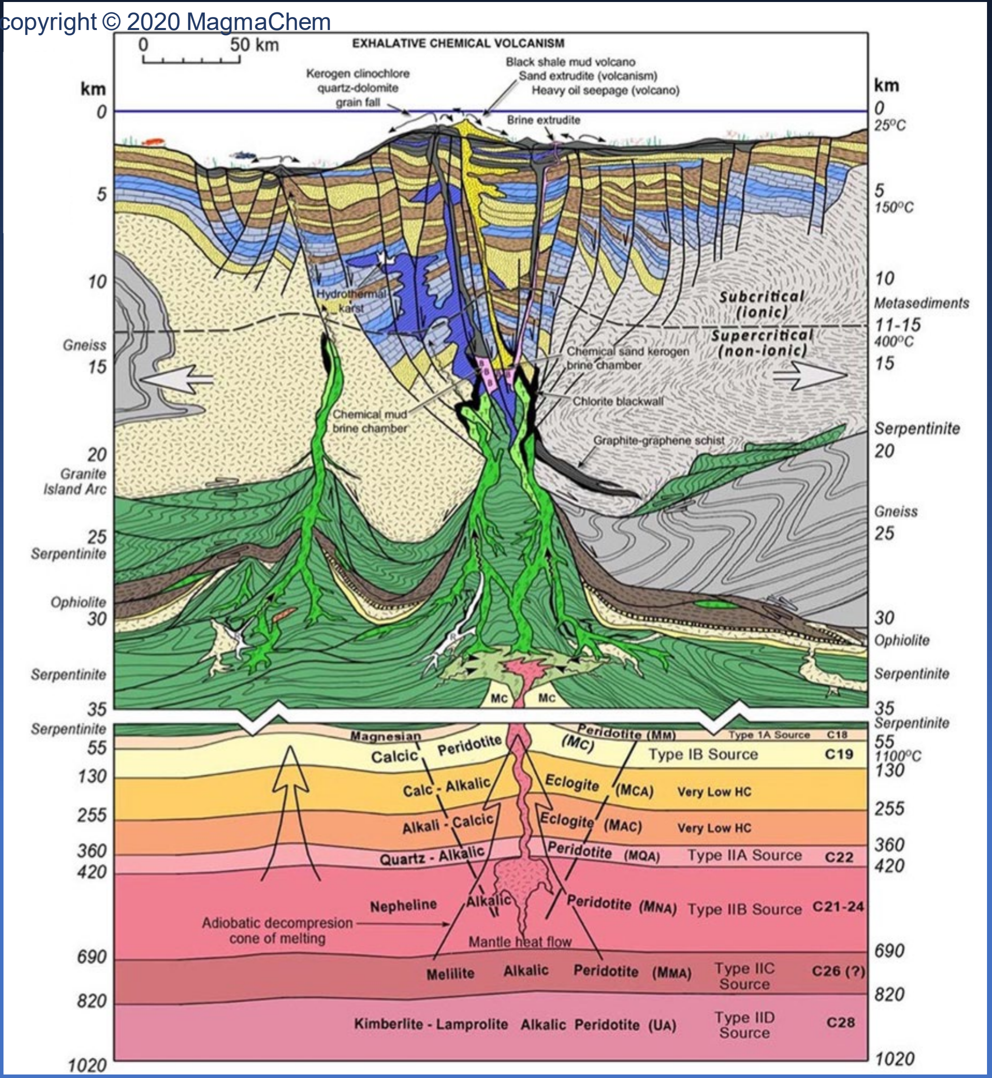
The UDH Model is an extremely viable hypothesis and is the potential **SOLUTION** for everything previously discussed and the best tool we have to move forward with a powerful explanatory framework against new information



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Anomalies in Conventional Petroleum Model

- Kerogen
- Serpentinization – Serpentine
- Diamondoids
- Dolomitization – Dolomites
- Silicification – Quartz
- Calcite
- Argillization – Black Shales
- Salinization – Brines
- Mud Volcanism
- Oil
- Biosphere

Anomalies in UDH Petroleum Model

- We currently have not found any data that cannot be explained using the UDH model

Layered Earth Model

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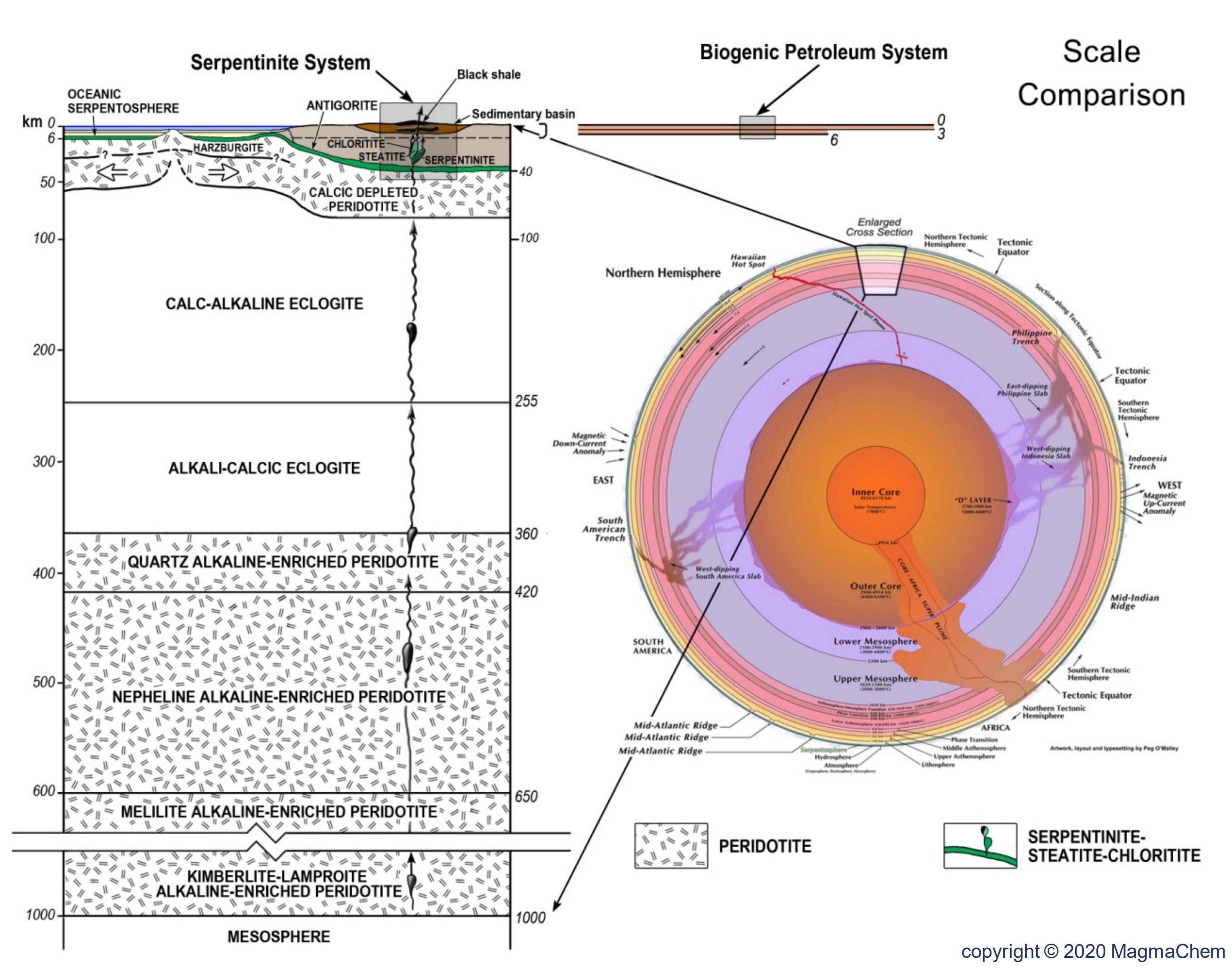

Layered Earth Model

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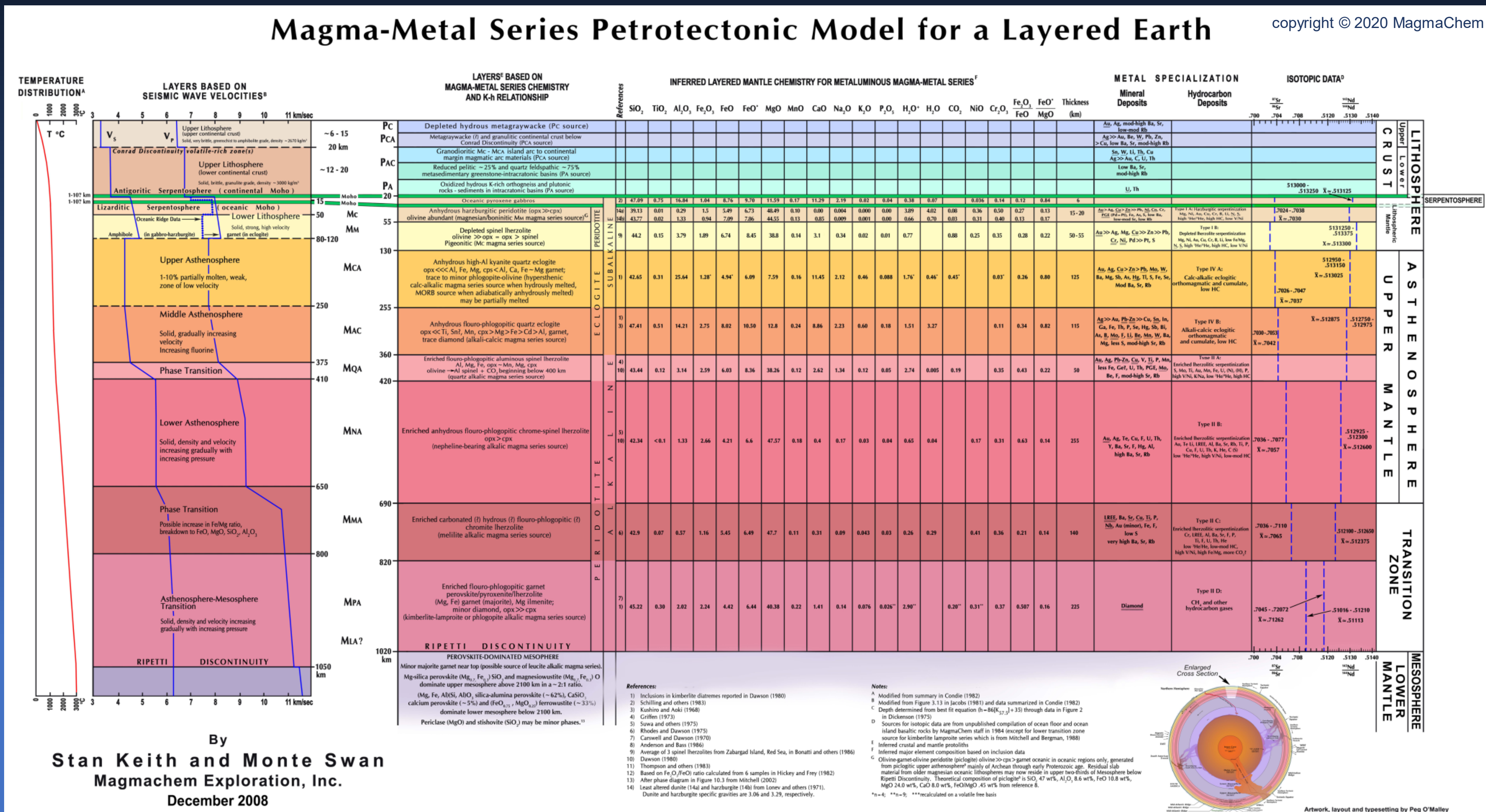
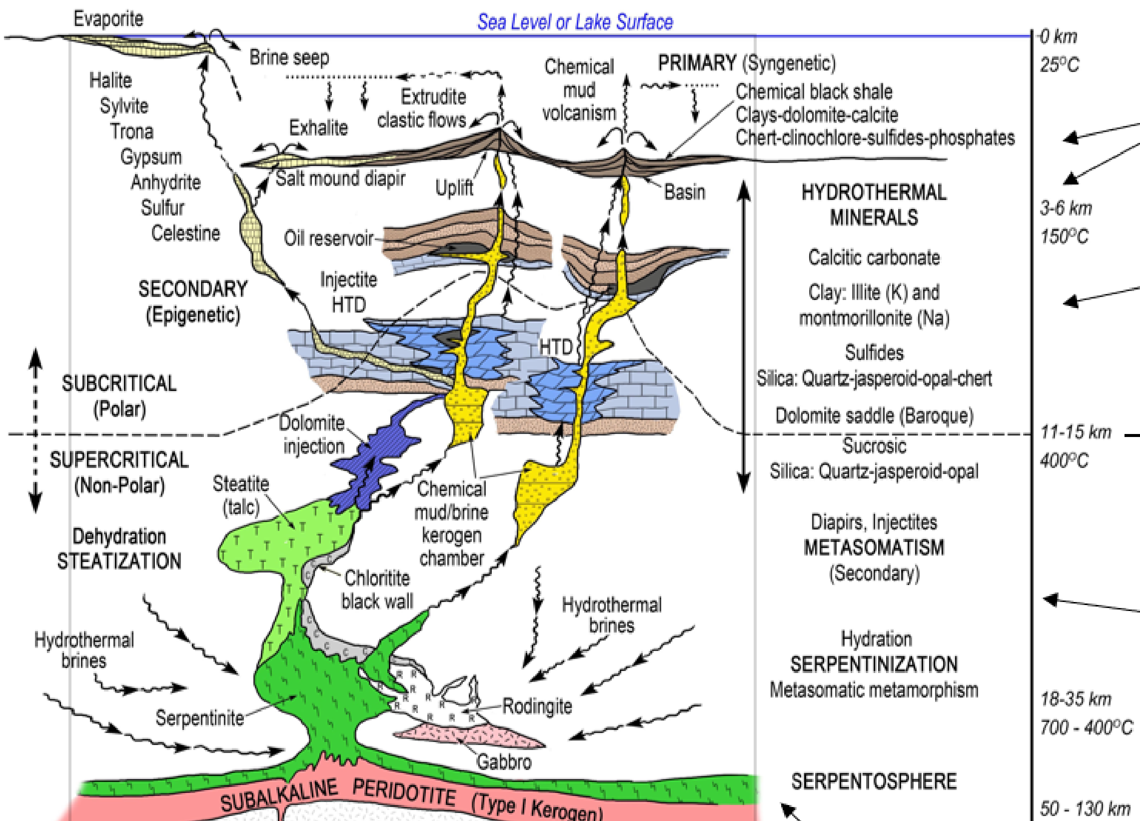




Oil carried by chemical mud to conventional reservoirs and black shales at the surface

Hydrogenation of kerogen producing oil as minerals crystallize out of the brine

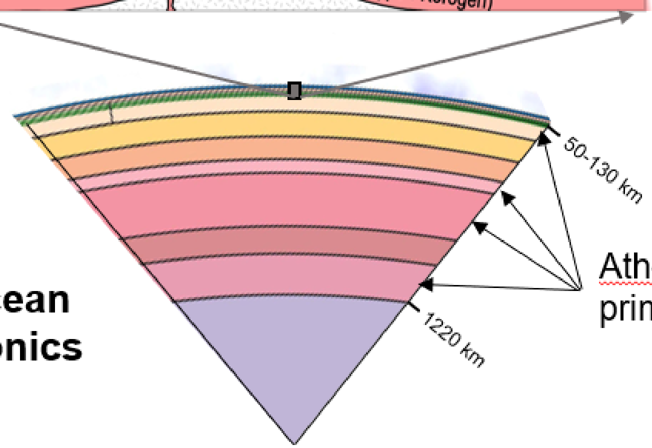
Diamondoid formation

Sub-Critical (ionic)

Super Critical (non-ionic)

Alkalated kerogen carried by serpentinite brines

Serpentinization causing transformation of mantle kerogen PAH 'seeds' to higher-alkane kerogen, producing **500-1500 ppm** alkylated kerogen



Athenophere layers w/ **10-50 ppm** primordial PAH kerogen

Liquid Ocean Plate Tectonics

Universal 'Cosmic' PAH kerogen

The Ultra-Deep Hydrocarbon Universe

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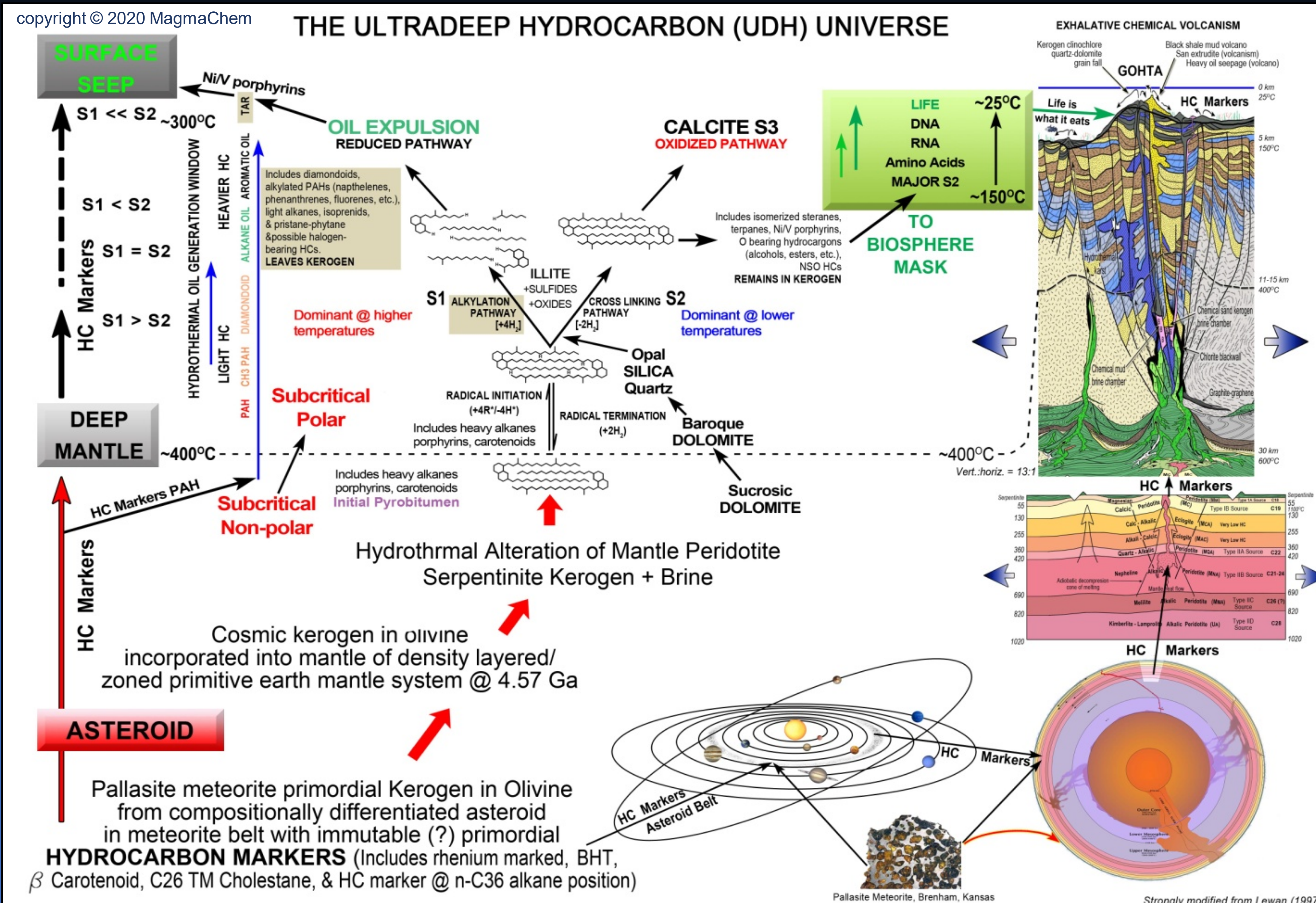

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Ultra-Deep Hydrothermal Research

End of Week 1

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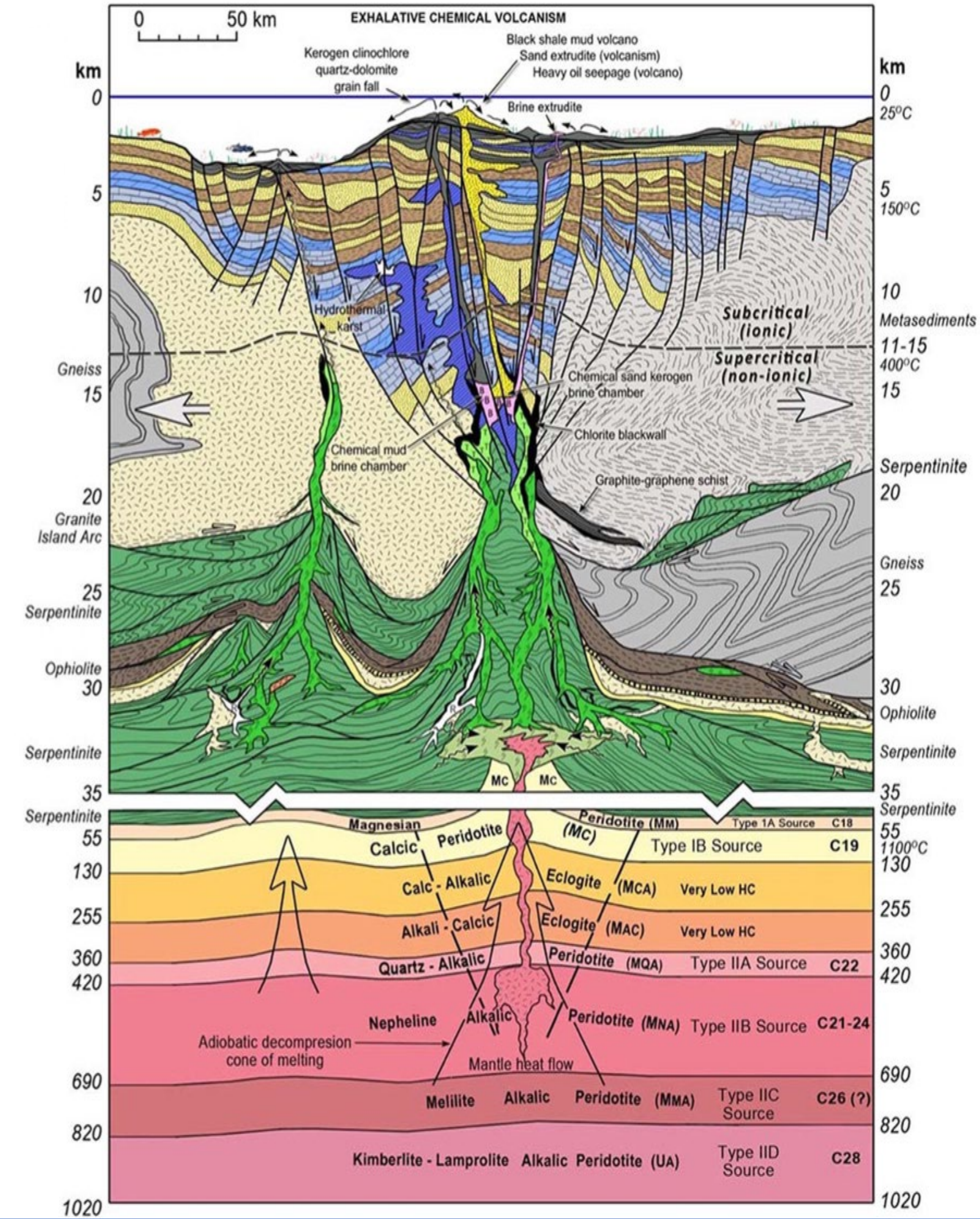

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