Primary Water
TECHNOLOGIES LLC

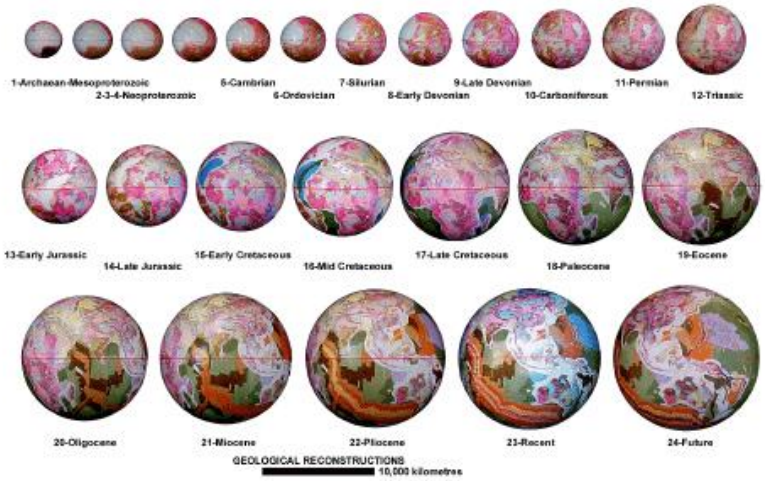
Introduction to Primary Water

2017

A Challenge to the Status Quo

"Academia partitions knowledge into physics, chemistry, geology, geophysics, astronomy, cosmology, and so on. Scientists, evolving toward ever narrower specialization, with diminishing knowledge of other fields, scorn the capacity of interlopers and resent their intrusion. Doctrines become inbred into creeds, and are stated as fact to others. Fundamental problems tend to be swept under the mat at the edge of the field. But nature herself knows no such barriers."

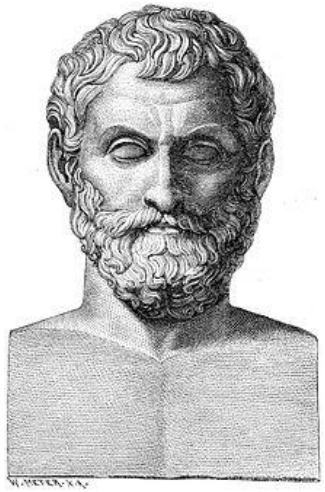
- Samuel Warren Carey, *Theories of the Earth and Universe*



The Primary Water Paradigm

"We're made of atoms. This is one of the most profound and far-reaching discoveries. The story of how we arrived at this insight begins over 2500 years ago in Greece, where Thales realized that any substance could be classified as solid, liquid or gas. ...In addition, he went further: ***water can exist in each of these forms—so might it be the case that all matter is nothing more than water?****"*

- Frank Close, The Cosmic Onion



History

- The concept of Primary Water is over 100 years old; attempts at programmatic rollouts in the U.S. have been tried in California (1950s) and on the East Coast (1990s). Australia has successfully proven these theories for over 25 years. The Germanic peoples have understood this for 500 years!
  - Most primary water specialists have operated for decades, locating water for private clients and occasionally municipalities; international work has been mostly one-off (e.g., Kenya, the Philippines) or for non-profits (e.g., Global Resource Alliance in Tanzania)
  - Primary Water location specialists on multiple continents have been identified for deployment worldwide

Adolf Erik Nordenskiöld

- 19th century botanist, geologist, mineralogist and explorer; later a member of the Swedish Academy
- Observed creation of new water deep in mines, often near surface when in presence of a catalyst such as quartzite, olivine, norite, etc.
- **Nominated for the 1st Nobel Prize in Physics for his fieldwork and paper on Primary Water**

Nordenskiöld

"About Drilling for Water in Primary Rocks" - 1896

"…It appears [after documenting 33 boreholes] that everywhere that one drills in the primary rocks in Sweden and Finland, **at a constant depth of a little over 30m** under the surface of the earth, **a water bearing horizontal fissure is encountered**. The theories about folding and the displacement of the primary rocks' surface layers by temperature variation have been clearly corroborated hereby…"

Nordenskiöld, cont'd

Adolf Erik Nordenskjold

"About Drilling for Water in Primary Rocks" - 1896

"…It comes free from the bacteria that exist in the earth's surface layers, from organic detritus, from decay produced and other things injurious to health and **for our purposes it is unexcelled in hygienic respects**, having a temperature transcending a little the average temperature at the place where the wells were drilled."

Stephan Riess

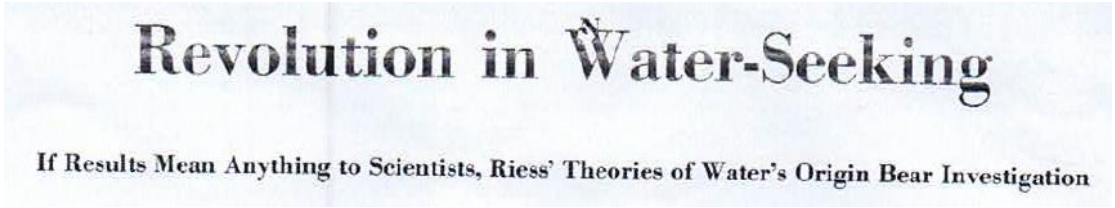
- Bavarian-born mining engineer
- Immigrated to the U.S. and worked for (later) President H. Hoover's mining operations throughout the U.S. West
- Developed concept of earth-generated water independent of Nordenskjold
- **Dug first primary water well in 1934**
- **Documented 753 primary water wells during ensuing 50 years**: U.S., Cyprus, Israel, Egypt, Saudi Arabia, Brazil, Mexico…

Riess

Stephan Riess with 1,900 gallon-a-minute well he drilled above bone-dry Simi Valley, California. Courtesy of The Riess Institute

"At no time is water static. It is constantly changing form. It is either a liquid or gas, or it is bound up in crystalline form in rocks and minerals. The cycle of gas to liquid to crystal is repeated over and over. **Oxygen and hydrogen combine under the electromechanical forces of the earth to form liquid water.** Not only is water being constantly formed within the earth, but also rocks, minerals, and oil. What I seek is water in its liquid state."

Riess Covered in Press 1953-1960



Revolution in Water-Seeking

If Results Mean Anything to Scientists, Riess' Theories of Water's Origin Bear Investigation

- 1953: *Revolution in Water-Seeking*, Fortnight magazine
- 1953: *Rocky Peaks Spout Water for Man Called Dreamer*, L.A. Times
- 1953: *Winter Rains*, Christian Science Monitor
- 1954: *New Source of Water for Desert Lands?*, Desert magazine
- 1954: *The Desert's Promise*, Christian Science monitor
- 1954: *Engineer's Test Wells Drafted Into Service*, CSM
- 1955: *Does He Get Water from Rock?*, Collier's
- 1955: *Water Sells for--$1 Million*, Christian Science Monitor
- 1957: *Mining for Water*, Christian Science Monitor
- 1958: *Coaxing Water Out of Rocks*, Jerusalem Post
- 1959: *Water From Arava Rock*, Jerusalem Post
- 1960: *From the Bookshelf*, Christian Science Monitor
- 1960: *Well Driller's $60,000 Claim Heads to Court*, L.A. Times
- 1972: *The Water Finder*, L.A. Times

Riess – “Bone Dry”Simi Valley 1955

Water Sells for--$1 Million
By Kimmis Hendrick Chief of the Pacific News Bureau of The Christian Science ...
Christian Science Monitor (1908-Current file); Oct 19, 1955;
ProQuest Historical Newspapers Christian Science Monitor (1908 - 1999)
pg. 3

Water Sells for—$1 Million

By Kimmis Hendrick
Chief of the Pacific News Bureau of The Christian Science Monitor

Simi, Calif.

Clinton W. Murchison of Dallas has paid $1,000,000 to Stephen Riess of Simi, Calif., for a parcel of ground just 200 by 80 feet in size.

This land covers the top of a rocky knoll where Mr. Riess has three wells yielding enough water, by the most conservative estimates, to support a population of 15,000 people—in a region where other well diggers get nothing but dry holes.

Mr. Murchison's move is a deliberate step to encourage Mr. Riess' now-famous contention that there are other sources of water than the precipitation cycle. It includes a provision for extensive research into the Riess method and findings.

"By studying the chemistry and the isotopes," Mr. Riess says, "we know that this is primordial water from the plutonic rocks."

For two years, Mr. Murchison he would build his home here, friends called him insane. But he put down a well and got water in great quantity, as he told them he would. About a year ago, when the nearby community was desperately water-shy, Mr. Riess started furnishing its utility district all the water it needed, free of charge.

Research Planned

Mr. Murchison, quiet by nature, simply looked the place over for about 15 minutes then said to a colleague, "Make the deal."

It is a sizable deal.

It includes Mr. Murchison's purchase, from Dr. L. M. Montgomery, of 1,500 acres adjacent to the Riess well site. These acres are also near secret installations of North American Aviation Company, where work for the government on special projects will soon require an available residential area.

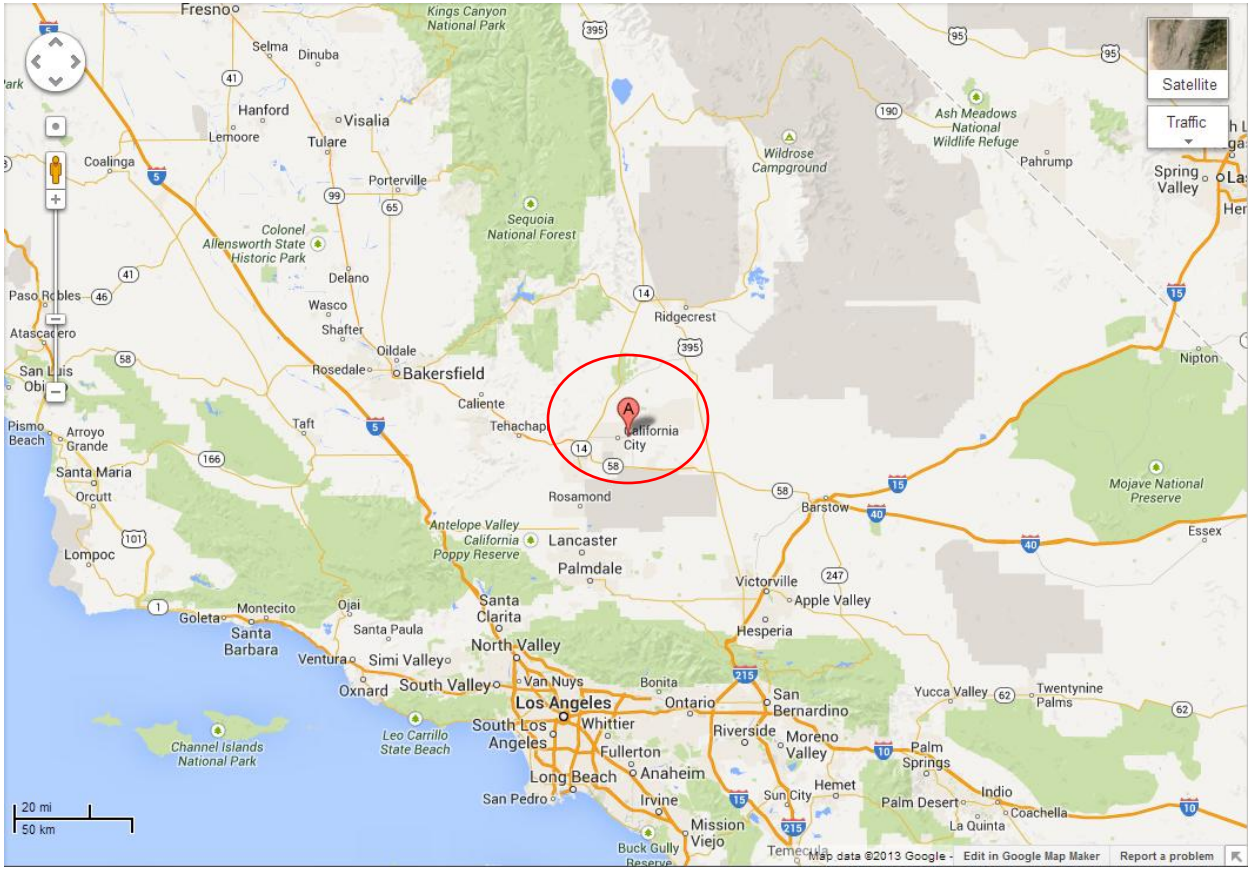
It includes the establishment of a foundation to be known as Riess-Search, to study the Riess method of locating water, pursue its application to arid lands generally, encourage global-scale reforestation, and train young geologists and engineers.

It leaves to Mr. Riess his home site, which he and his wife have turned into a place of almost tropical outdoors beauty as setting for a house among chemists, physicists, and now famous for hospitality many other friends throughout the world.

These people know "Steve" Riess as almost a fanatic advocate of the idea that untried approaches to hard problems are generally surer paths to success than the accepted textbooks. And this, obviously, was what appealed to enterprising

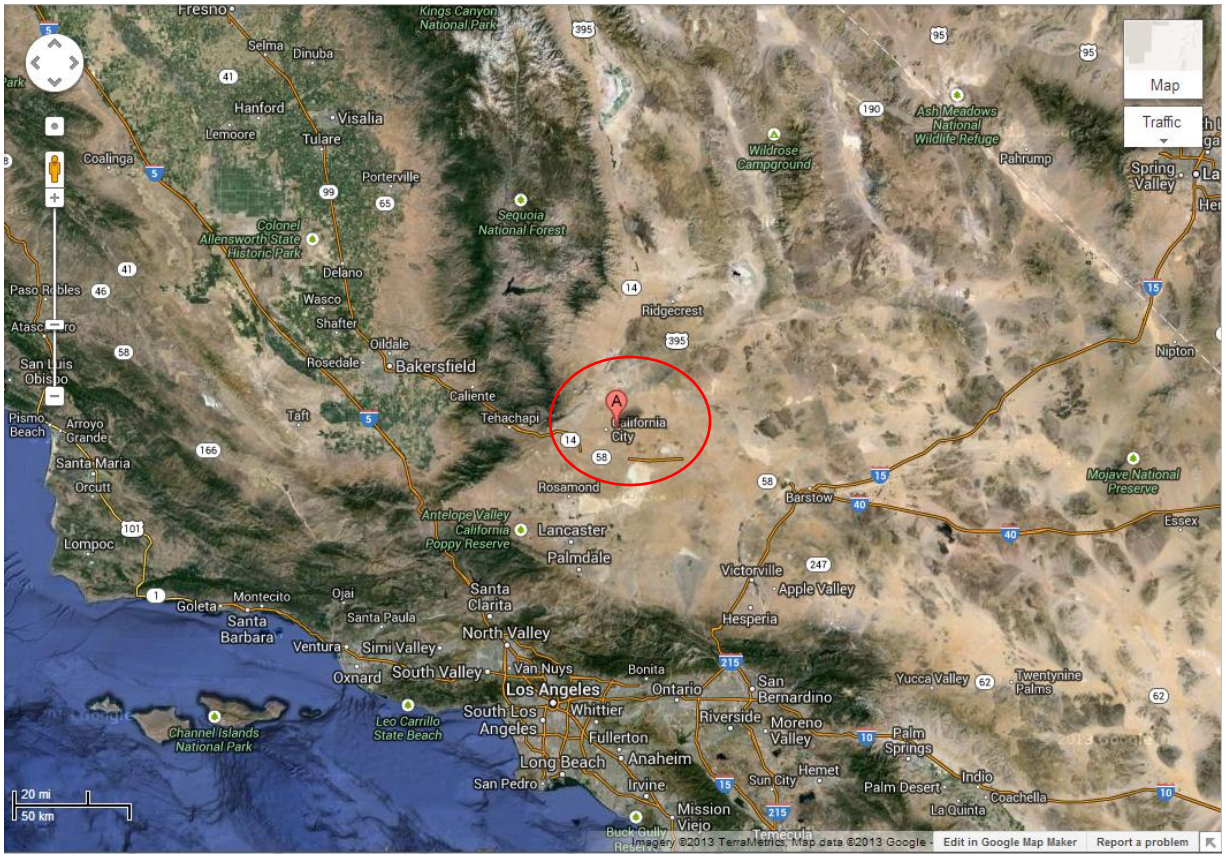
Riess: Capstone Project

Stephen Riess c. 1980 at one of the wells drilled for California City in the middle of the Mojave Desert



Riess: Mojave Desert

Stephen Riess c. 1980 at one of the wells drilled for California City in the middle of the Mojave Desert



Riess: Develops California City

Stephen Riess c. 1980 at one of the wells drilled for California City in the middle of the Mojave Desert

Postcard of Central Park, California City, CA, c. 1960

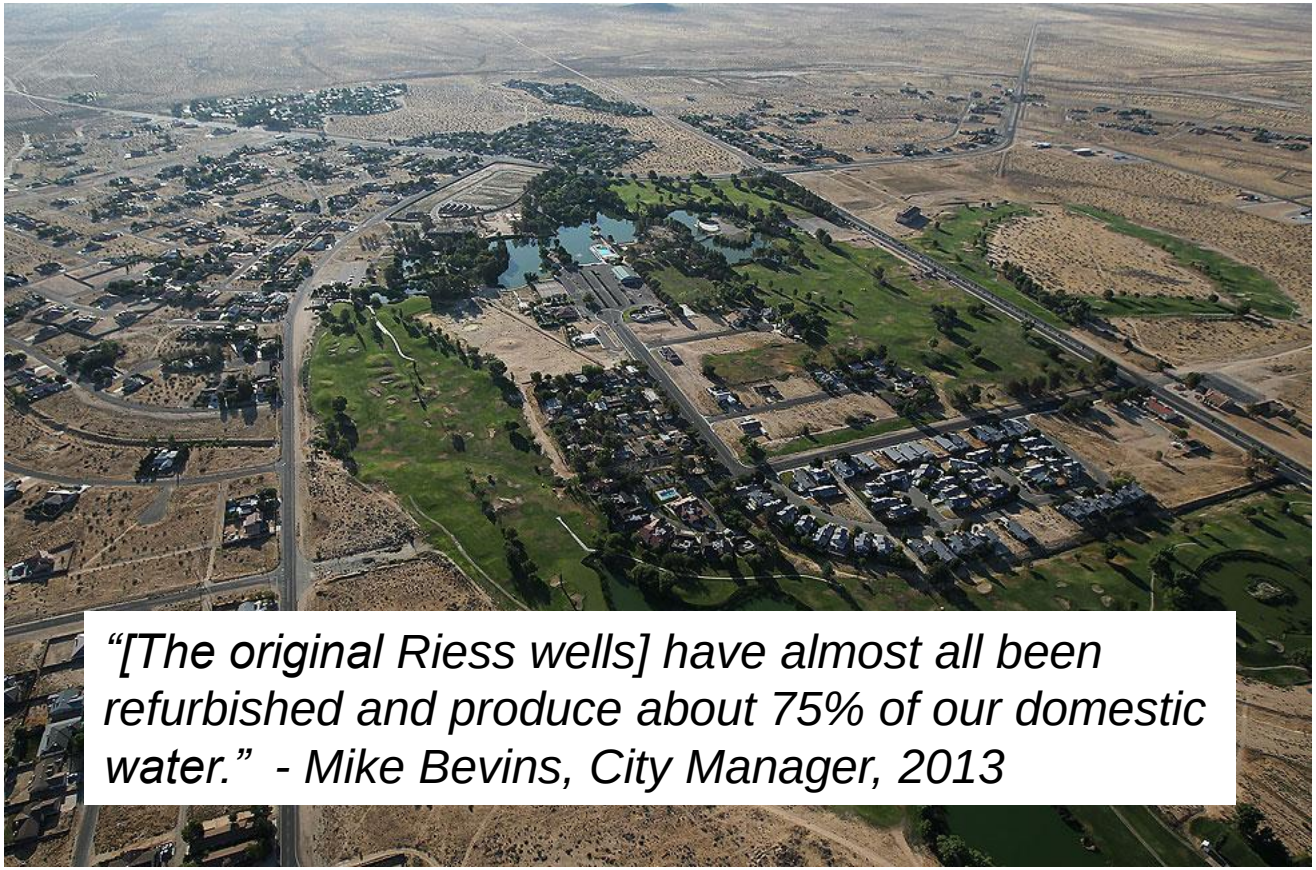
Riess: Over 50 Years Later…

Stephen Riess c. 1980 at one of the wells drilled for California City in the middle of the Mojave Desert

Aerial Photo of Central Park, California City, CA

Riess: Over 50 Years Later…

Stephen Riess c. 1980 at one of the wells drilled for California City in the middle of the Mojave Desert



"[The original Riess wells] have almost all been refurbished and produce about 75% of our domestic water." - Mike Bevins, City Manager, 2013

Aerial Photo of Central Park, California City, CA

Riess: Over 50 Years Later…

Stephen Riess c. 1980 at one of the wells drilled for California City in the middle of the Mojave Desert

Aerial Photo of Central Park, California City, CA

Riess – Middle East

- Israel, Egypt, the Sudan and Saudi Arabia
  - By 1958, Stephan Riess's work with L.A. developer Nathan Mendelsohn was brought to the attention of the Israeli government who invited him to find water for their new city of Eilat on the Red Sea's Gulf of Aqaba. Riess met with then Prime Minister David Ben-Gurion and his advisors who urged him to go ahead with his search for water as soon as possible. **On May 29, 1959, the Jerusalem Post announced that the Riess-located well was sufficient enough to supply a city of more than 100,000 people including industry and outlying villages.** Riess next traveled on to Egypt at the invitation of President Gamal Abdul Nasser and sank three wells for private landowners. He continued on to the Sudan and finally to Saudi Arabia where he sank fresh water wells north of Ras Tanura next to the Arabian Gulf for then Crown Prince Faisal.

Riess – Eilat...Wadi Araba 1959

U.S. Mining Engineer Performs 'Miracle' in Negev

WATER FROM ARAVA ROCK

By Meir Ben-Dov

IT was hot, dusty and dry — as usual in the Arava — when we went down to investigate the story of the magic pools of water, captured in solid desert rock, which two pioneering American mining engineers have succeeded in bringing to the surface, opening new vistas for the development of the southern Negev.

The hills of the Negev are grim and ferocious; the wadis are bleak and dusty. Once in a decade a flash flood comes down the mountains, along the wadi bottom, engulfing everything under its high wall of milling torrents, but a brief hour later it has dwindled to a narrow trickle. The water gives new life to the thorny shrubs and the brittle trees, bringing forth a burst of green shoots. It is by these occasional, short-lived floods, that life in the Arava measures the passage of time: the occasional drops of rain in the winters between the flood-years are only enough to keep the vegetation from dying away altogether.

A month after the winter's last few drops have fallen the desert is parched; hot, scurring winds blow off the sun-scorched rocks; the gravel is the only reminder that here, twice in a generation, a

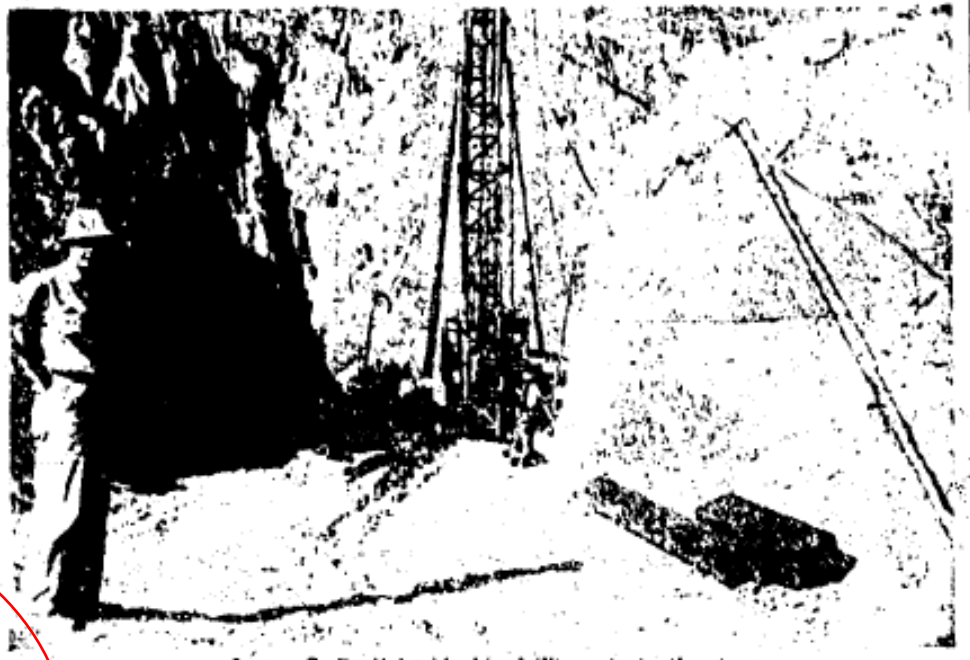
choking smell of powdered rock. It is like the smell of rich farmland when the sun breaks forth after the first thunder-storm of the year.

A tall thin man, sitting on a rock, watching the twisting line of the rig, slowly raises himself up to his full height, a smile creases his granite-like face, and he greets you with a "shalom" in a soft drawl. He is James G. Scott, a mining engineer and geologist, trained at the University of California. Forty-four years old, he is now drilling for water in Arava rock.

Every amateur geologist and water expert in Israel knows that one drills for water where rain has seeped through porous limestone or through alluvial soils, but never, never in impermeable granite. The same self-evident phenomenon is acknowledged the world over.

Water in Deserts

There is one man, though, who thought otherwise: Stephan Riess, an American mining engineer, oil and water prospector whose slightly guttural accent and softened P's and T's betray the fact that his birthplace, 60 years ago, was Bavaria. Riess has his own theories about nearly all aspects of geology, and they are nearly always borne out by practical results. He claims — and drillings



James G. Scott beside his drilling rig in the Arava.

holding into a prosperous residential city. Mendelson, who believes in "do-it-yourself" Zionism, then sent Riess to find water in the Arava. The first drilling — since it would have been hard to convince engineers of the practicability of the project — is at Mendelson's expense.

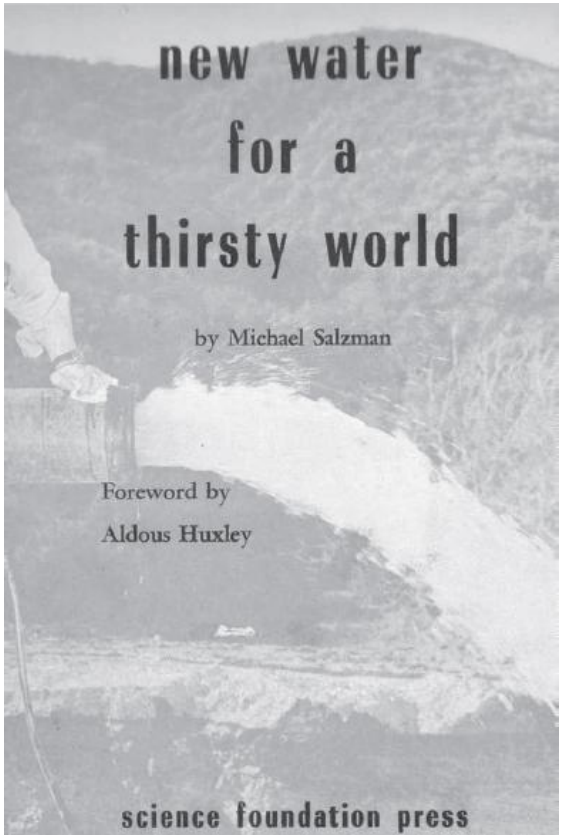
Riess explains the presence of water in granite rocks with a simple theory. As the Earth cools off, material from the gaseous core forces its way upwards through fissures in the rock crust. Elemental hydrogen and oxygen combine, and when they reach the outer layers, condense as

running vertically through the mountain, is crossed, at right angles by a similar cleft, hardly 20 centimetres across. The bowels of the Earth in erupting have filled the clefts with an igneous intrusion of a soft, soapy-feeling, mottled brown rock, called gabbro.

Bulldozers have scraped away the soft gabbro in the wider cleft, to form a level platform for the cyclone rig used in drilling. Standing next to this drill, James Scott leans against the rock face, breaking off small lumps for his visitors' inspection. A soft brown clay has been pushed

Mindner, the drilling foreman, got his experience drilling for oil in pre-war Poland. Joseph Hoppman, whom Scott describes as one of the best welders he has ever met, resurfaces the drill steels and builds up special pieces to Scott's design, to cope with various problems in the rock. His is one of the key positions in the drilling team — the same position that he held with Mindner in Poland 20 years ago. Manchester-born Erich Brandreth doubles as drill operator and interpreter. Eric, a Gentile married to an Israel girl, has been in this country since 1951. His

Michael Salzman



https://babel.hathitrust.org/cgi/pt?id=mdp.39015004595248;view=1up;seq=7

- USC Professor with multiple PhD's in the fields of business finance, organization and management, social psychology, social science research methods, and sociological theories
- Focused on water issues from 1954-1960
- Published "New Water for a Thirsty World" in 1960 (hardback and paper)
- Steve Riess provided much of the material for the book
- Nearly every copy was bought up and destroyed by Gov. Pat Brown and his supporters of the California Canal…

Salzman on Piezoelectricity

"The **relationship of elastic quantities to electric quantities** is apparently not described in structural geology books. However, Voigt has shown how **the elastic quantities (stress and strain) and the electric quantities (field and polarization) are related by** the piezoelectric coefficients or their inverse values, **the piezoelectric moduli**…. In the rocks of the crust of the earth, rupture is expressed by cleavage, joints, and faults. **Many ruptures now occupied by dikes or veins** are the concern of the petrologist or the economic geologist, whereas the origin of the rupture itself remains the concern of the structural geologist.... Petroleum geologists have found that the **extensive deposition of ore minerals along faults** usually denotes poor prospects for oil production. These very same occurrences, however, **may be favorable for primary water production**.... Specifically then, **pyroelectricity** is electricity or electric polarization produced on certain crystals by **change of temperature**, whereas **piezoelectricity** is…produced by **mechanical strain** in crystals of certain classes…. The occurrence of **ferromagnetism** and **spontaneous polarization**, in conjunction with the heat from intruding magmas or from radioactive rocks **may actually begin a process of electricity within the earth**…. **Electric current**, passing through solutions, decomposes them and **results in the liberation of gases or metals**, and is known as **electrolysis**. ***If hydrogen and oxygen are present at certain specific temperatures, or in the presence of a catalyst, they unite to form water.***"

Salzman: Political Backdrop

California State Water Project

- Feather River Aqueduct was the answer to another round of extended drought
- Required the construction of 21 dams and more than 700 miles (1,100 km) of canals, pipelines and tunnels
- Initial bond raised $1.75 billion; to date the state has spent $4.3 billion and counting
- Aqueduct crosses two major active faults
- Today, another round of “water wars” has begun as Southern California seeks to take more river water from Northern California
- **Drilling wells is the only alternative for most farmers and growers!**

SOME GEOLOGIC ASPECTS OF THE STEPHAN RIESS CONCEPT OF FINDING PRIMARY WATER

"While the problem of the formation of primary water is strictly one for the geochemist, on the other hand it is just as obvious that the problem of origin of the channels of migration and the passage of water through them is one for the geologists. Primary water was known to the ancients and has been known all through the ages up to the present; **nevertheless, because the geologists, hydrologists, and other scientists simply did not know how to discover the water, it was ignored**. Primary water was discussed by a few scientific writers, but little was done to find out its general characteristics or how to find it."

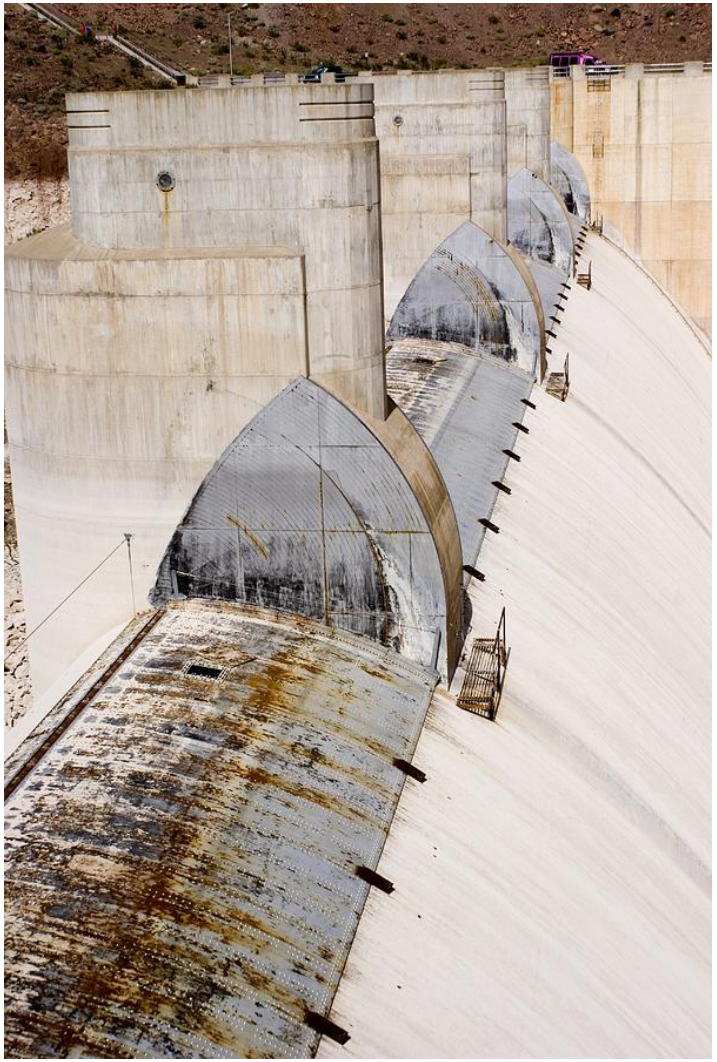
- Ralph Arnold, Consulting Geologist*
(Copies filed 1960 at U.S.G.S. and Banner Club at Cal. Tech)

* *Largely credited for the oil discoveries of Venezuela*

The Future?

Will building dams and aqueducts solve the world's water shortages?

Will digging alluvial rain-fed wells deeper solve the problem?



Sluiceways of Hoover Dam now rusting…

SCIENCE & NATURE (2010):

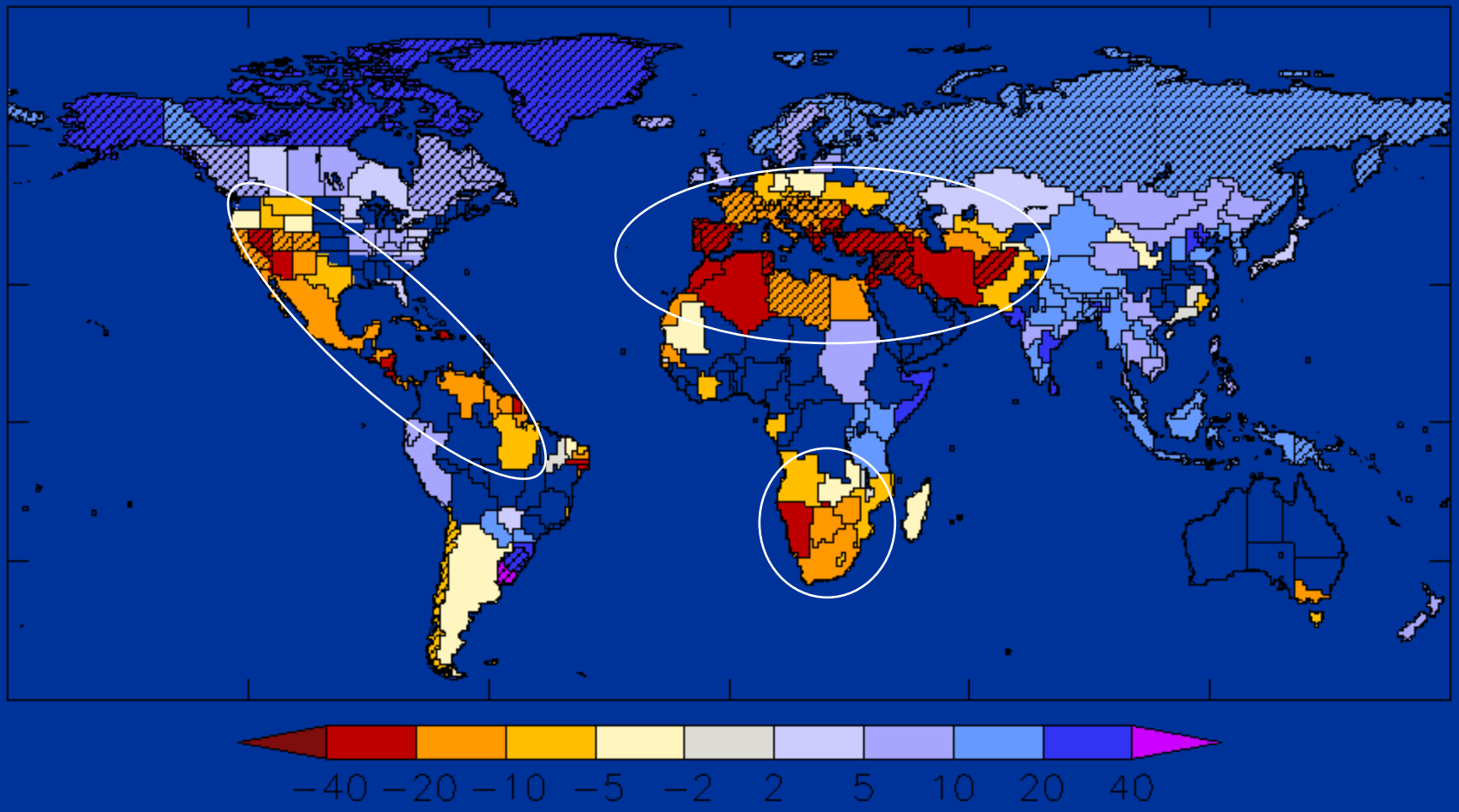
“The Colorado River Runs Dry”

Dams, irrigation and changing climate patterns have drastically reduced the once-mighty river.

Is it a sign of things to come?

Model-Projected Changes in Annual Runoff, 2041-2060

Percentage change relative to 1900-1970 baseline. Any color indicates that >66% of models agree on sign of change; diagonal hatching indicates >90% agreement.



USGS

(After Milly, P.C.D., K.A. Dunne, A.V. Vecchia, Global pattern of trends in streamflow and water availability in a changing climate, *Nature*, **438**, 347-350, 2005.)

Primary Water Well Inventory

- Modern Discovery: A. E. Nordenskjold (1890's)
  - 31 (of 33) wells drilled through bedrock in Sweden
  - Primitive methods, including the use of dynamite
- Method Creator: Stephan Riess (first 1934, last 1985)
  - 753 documented primary water wells on four continents
  - Advanced mid-century drilling techniques
  - Contemporaries included Verne Cameron , Bill Cox, Ralph Arnold
- The Riess Institute: U.S. East Coast (1980's-2000's)
  - Included senior scientists from Massachusetts Institute of Technology
  - Deep and shallow wells drilled in New England and New York
  - Rotary air drill rigs for deep and shallow borehole drilling

Inventory, cont'd

- Thousands of more wells drilled and producing!

- Riess Disciple: Pal Pauer (1960s to the Present)
  - Petroleum Geology at U.C.S.B.
  - Spent 10 years learning the method
  - Lifelong friend and disciple of Riess
  - Wells all over the US Desert Southwest and internationally, including…

- NGO: Global Resources Alliance
  - Non-profit, now owns drill rig in Africa
  - Over 120 wells for Maasai-Mara in Tanzania
- Rotary International of Santa Barbara
  - Two very successful projects in Kenya
  - "Miracle Well" at Ngu Nyumu outside Machakos
  - Well for the Maasai in Amboselli
- Projects under planning in Uganda and Madagascar

Non-Profit Success

- Global Resources Alliance
  - NGO based in Ojai, California
  - Focused on humanitarian work in Tanzania
  - Mara District in arid west, near Lake Victoria in Rift Valley
  - Over 120 wells and now own a rotary air drill rig (PRD-India)
  - Locally field-trained proficient water locator/driller
  - *Maji Mengi* ("Abundant Water") 10-minute documentary:

http://www.youtube.com/watch?v=prhK7zUWXTE

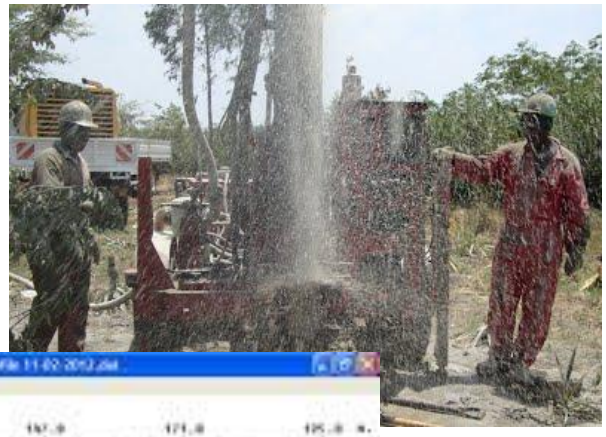
What does this teach us?

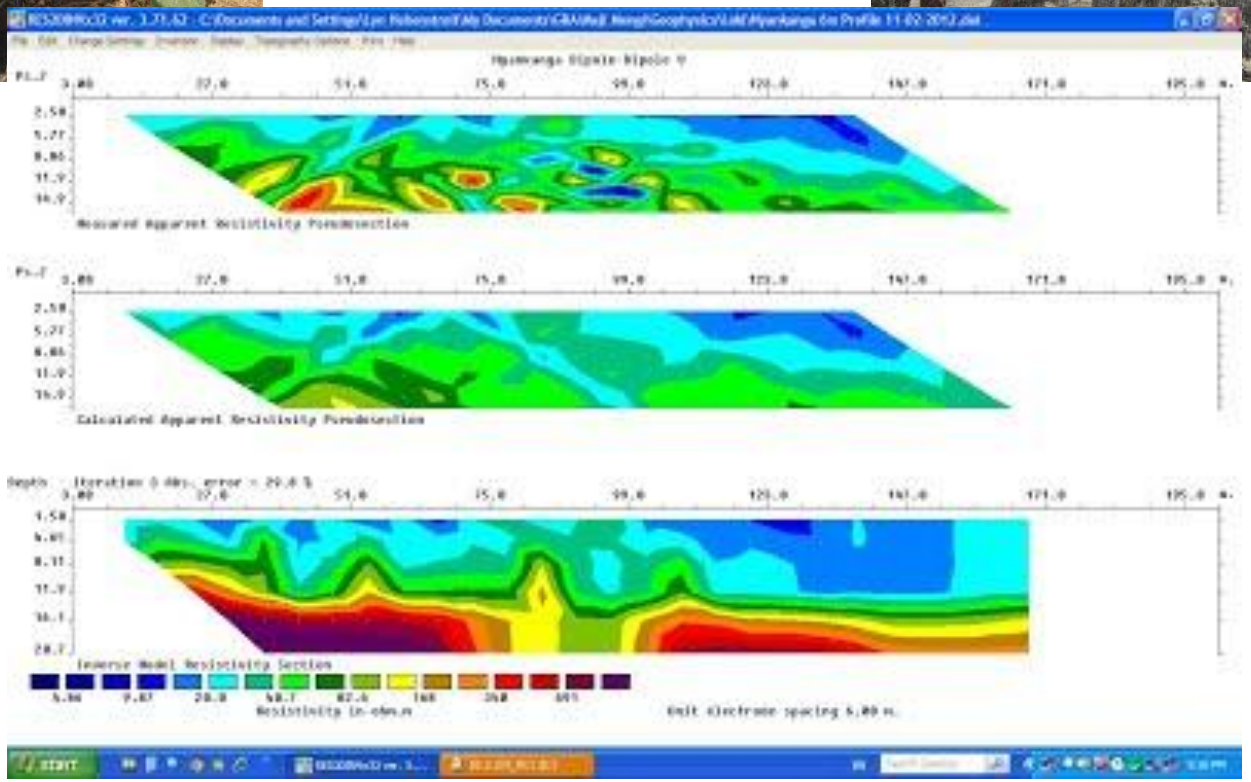
- Global Resource Alliance – US/Tanzania
  - Example of ongoing programmatic rollout
  - Water well depths are almost all less than 200 feet / 60 meters
  - Cost per well can be lowered significantly
  - Local resources can be trained

Primary Water Boreholes

"We drill hard-rock boreholes to tap clean, protected and abundant sources of water trapped in the fractures and fissures of the bedrock below. **The average GRA-Tz borehole is about 50 meters deep.**"

www.gra-tz.org





Deploying advanced resistivity system

Australia: Rob Gourlay

- Hundreds of PW wells located, drilled and producing!
  - B.S. & M.S. in Applied Sciences; first ADF environmental officer
  - Principal environmental scientist specializing in biological research, resource assessment and management
  - Professional experience since 1992 in biological research and consultancy in natural resource assessment and management, technology innovation and application in the areas of remotely sensed data, soil and water management, biological farming and trace mineral applications
  - **Led the world leading development and application of techniques in the use of airborne radiometric data for mapping salinity, other soil properties, water and minerals**
  - **Pioneered a new mapping technique in the location of deep fractured rock Primary Water sources**

California and Japan: Bill Cox

Primary Water

Home | About Bill Cox | Bill At Work | Lake Elsinor Project | Drilling For Primary Water

Bill Cox at work

Bill cox inspects the inflow into a clients reservoir from one of his Primary Water well sites in 1991.

Bill Cox and a geo-hydrologist inspect the power system serving one of Cox's mountaintop Primary Water wells near Pala, California. Drilling into deep rock fissures released immense subterranean pressures to produce a sudden and continuous free flowing column of Primary Water 150 feet high.

Bill Cox lectures to scientists, geologists and business men in Japan about Primary Water and his experience in finding it over a 30 year period.

Bill Cox Dowsing for a client

Bill Cox Dowsing in Japan

Siting a Primary Water well location in Japan. The well reportedly produces 130 gpm

Dr. Bickel: U.S., Canada, Mexico, Brazil

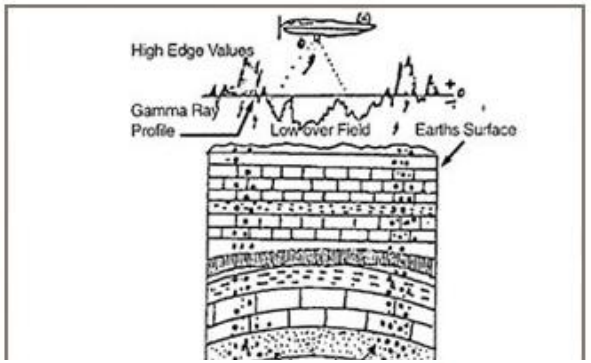
HISTORY GAMMA-EXPLORATION

My special thanks to Dr. Armin J. Bickel, who introduced me to the "secrets" of scintillation counter technology and who - at his age - still answered my many questions with clarity and in detail. (citation: Edgar Gummerum)

Dr. Armin J. Bickel, born in Sondershausen in Thuringia, was a master at watch-making and started his career as an astrophysicist at the research centre of Pennemuende, where he was involved in the development of the V2-rocket. During the 50s, he immigrated to Canada. Later, until his retirement, he worked on different rocket development projects and did research on space technology under Werner von Braun at NASA, mainly in Lompoc, California, "Western Missile Test Range".

After retirement, Dr. Armin J. Bickel found - in the 70s - ISOTOPE GEOLOGY & MINING EXPLORATION INC. Neutron activated sensing - mineral, oil, gas, and water. As an expert on natural nuclear reactions he used his extensive work experience and developed special scintillation counters which he used to prospect water, oil, diamonds, and minerals. He sold his devices and even used them himself with great success in several countries. Among others things he undertook geological examinations for large constructions, where the nature of the bearing material was of great importance.

Dr. Armin J. Bickel also did research in other fields: within a research project he treated the roots of plants with a ultrasound-frequency and achieved oversize growth. In the case of lemon trees, the fruits tripled and quadrupled in size. Sunflowers also became oversized, taller. It was interesting that the stem of the plants also adjusted to the fruit size. He was an endowed researcher and had a wide knowledge spectrum, most of his finding not available anymore today. Until his death he lived in Lompoc, California, close to Vandenberg Air Force Base.



http://transformative-technologies.com/water-exploration.html

Accidental Occurrences

- Mining Floods
  - Arizona: Tombstone Mine flooded out 1880s, unable to continue mining
  - Nevada: Eureka 1947 - Fad Shaft at Ruby Hill at 2250’ level struck the Martin Fault; pumping at **9000 gpm** did not recover the level
  - Nevada: Eureka 1949 - Eureka Mining Co Ltd flooded; later pumped **7500 gpm**
  - Nevada: Jarbridge Mine at elevation of 6200’, **7200 gpm** from the 1000’ level
  - Nevada: Virginia City Comstock Lode silver mines flooded at 3000’ by hot water
  - Nevada: Virginia City Mahr Tunnel at 1700’ below surface cut a fissure that flowed hot water at **18000 gpm**!
  - Peru: Casapalca, C. Francisco Mine drainage tunnel encountered fissures; produced more than **10000 gpm**
  - Peru: Morococha Natividad at 1014’ level flowed **30,000 gpm**!!

100-degree tunnel temperatures, aggravated by 117-degree water from underground fissures, forced Tecolote Tunnel workers to be transported in "bathtubs"—mine cars filled with cool water. These "baths" were used by the overheated men to cool themselves by riding up to their necks in water, fully clothed.

Manhattan, NYC

- Contractor Psaty and Fuhrman Inc., under contract to the NY Dept. of Public Works, on February 14, 1956, at the intersection of 5th Ave and 136th St. in Harlem, on a lot 130’ by 175’, about 12’ underground, **encountered 64° F water flowing at >2,200 gpm**. Harlem Hospital chemists certified the water fresh, free of sewage, and fit for human consumption without treatment or chlorination, ruling out the nearby polluted Harlem River as the source.
- The folly of man: Harlem Hospital Center, still at that site today, sealed off the water as they saw it as a problem…

Excavations and Springs

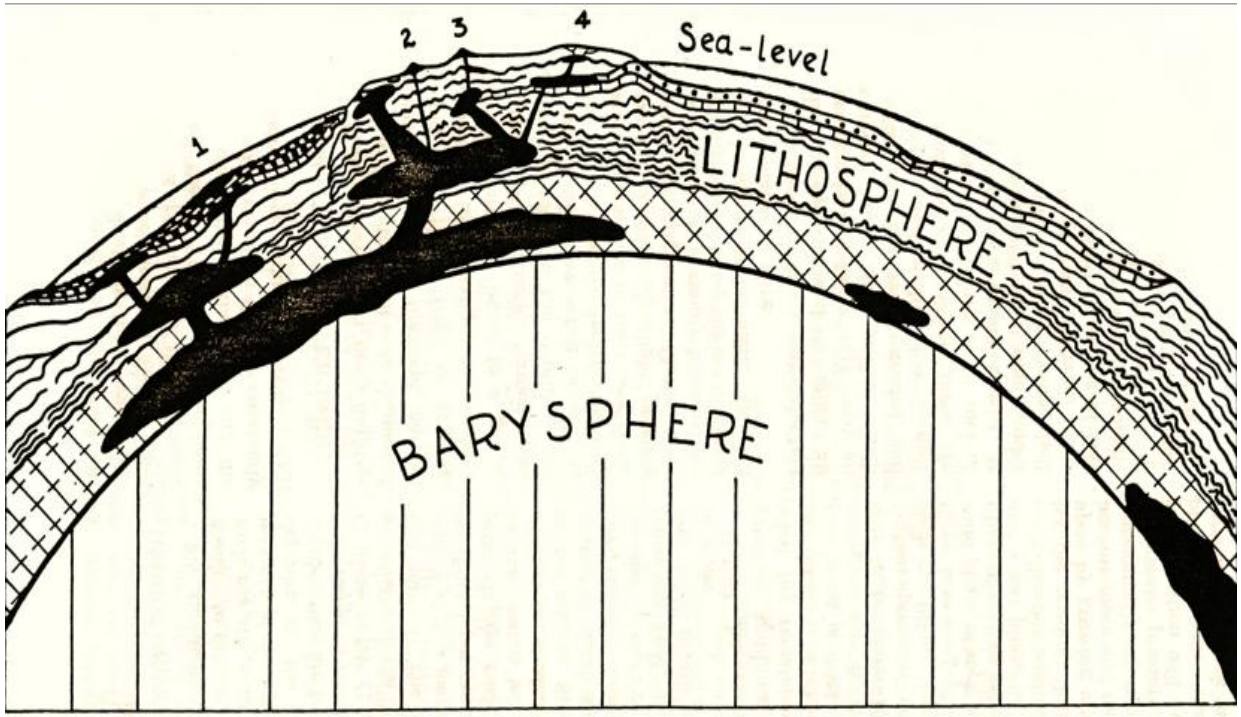
- Algeria: Zaghuan, 48 miles from the site of ancient Carthage, near modern day Tunis
  - Enormous spring flows through still-standing Roman temple on slopes of the Atlas Mountains
- Jordan: Mount Hermon
  - Eastern-most source is a full-formed stream bursting from the base of an earthquake-battered cave in a massive limestone cliff
  - Western-most sources originate as one spring at the foot of a Mount Hermon buttress. Water cascades from the cliffs as waterfalls
- Palestine: Jericho *Ain es-Sultan*
  - Water flows today from "The Sultan's Spring", just as it has since Neolithic times
- Libya: Cyrenaeca in the northeast, Fountain of Apollo
  - Gushes from a tunnel hewn into rock, as it has since the time of Aeneas over 3000 years ago
- Syria: Damascus, *Ain Figeh* Spring
  - Supplying average of 132,000 gpm (8.33 m^3/second) at 14° C and 7.9 pH
  - Supplies 1.3 million people in Damascus
- California: Santa Barbara, Santa Ynez Mountains, Tecolote Tunnel drilling
  - Encountered 9,000 gpm, 112° F source.; flowed from 1950 to 1957 before being walled off

Where is Modern Science?

- Specialization has overtaken broader fields of knowledge and multi-disciplinary research
- Group-think and outright dogma has crept into academia, especially in hydrology and geology
- However, advances in remote sensing have re-focused astrophysicists together with geo-chemists, geo-physicists and biochemists to re-examine the Earth
- We propose a new discipline: **geo-hydrology**!
  - I.e., the study of earth-generated water using physics, chemistry, biology, mineralogy, crystallography… in addition to geology, petrology and hydrology

Oceans of Water?

- Concept drawing: Verne Cameron, **1960s**



1-lava poured out under the sea; 2&3-volcanoes; from a great mass of molten rock deep down in the earth's crust; 4-liquid and gaseous solutions under great pressure inside the magma creating cracks in cooling rocks.

“Oceans Of Water In The Earth's Core”

http://adsabs.harvard.edu/abs/2002AGUSM.M42A..04S

Abstract (**2002**)

Saxena, Dubrovinsky, Rekhi, Wang, Shen

“While the debate on the chemical composition of the outer core continues, **it is essential that we consider water as an important core substance for the reasons that it is abundant and suitably light enough to decrease the density and melting temperature of iron.** Furthermore, if water is indeed stored in the core, it should provide a suitable source for water in the mantle and affect the dynamics of melting everywhere. **We have conducted several experiments** to understand the iron-water chemistry at high pressure and temperatures… **which has led to the important proposal of including water (and thereby hydrogen and oxygen) in the core…even a percent of water in the core will amount to ten times more water than that present in the oceans.**”

“Huge *Ocean* Discovered Inside Earth”
aka “The Beijing Anomaly”

http://epsc.wustl.edu/seismology/michael/web/lawrence_and_wysession_2005_MONOGRAPH.pdf **(2005)**

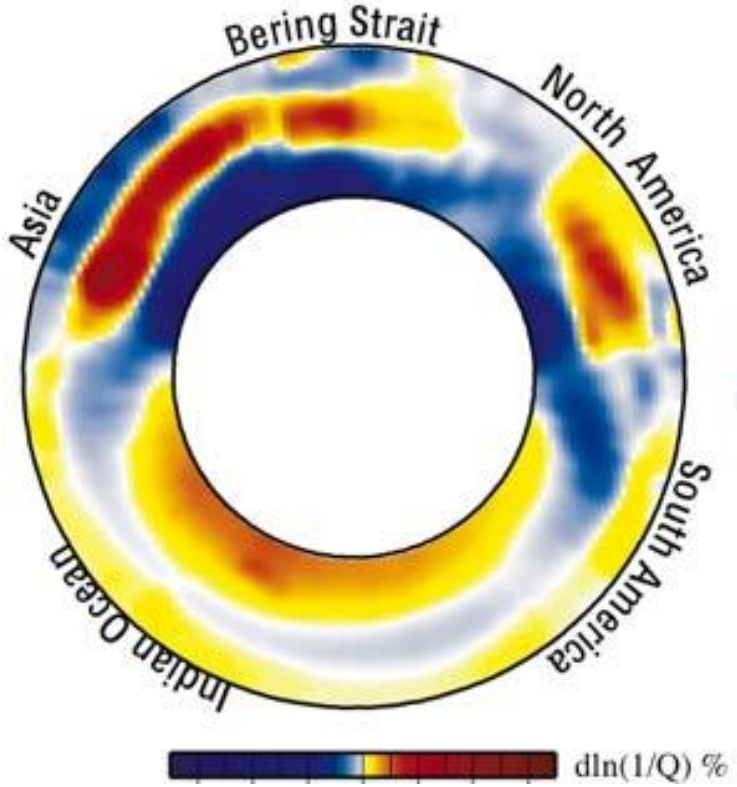
http://www.livescience.com/1312-huge-ocean-discovered-earth.html (2007)

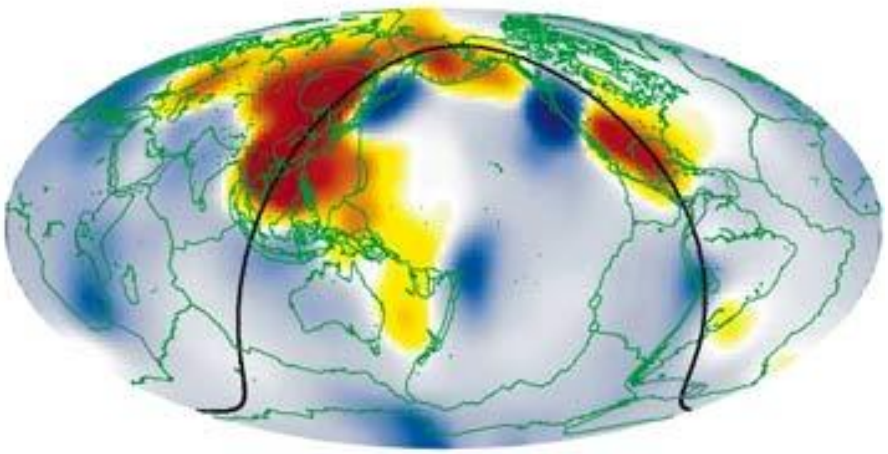
J. Lawrence (Scripps Institute of Oceanography) & M. Wysession (Washington Univ., St. Louis)

“Scientists probing the Earth's interior have found a large reservoir of water equal to the volume of the Arctic Ocean beneath eastern Asia. *The left figure [next slide] is a slice through the Earth, taken from the figure on the right, showing the attenuation anomalies within the mantle at a depth of roughly 620 miles. In both images,* ***red shows unusually soft and weak rock believed to be saturated with water,*** *and the blue shows unusually stiff rock (yellow and white show near-average values).”*

“Huge *Ocean* Discovered Inside Earth”

aka “The Beijing Anomaly”





“Huge *Ocean* Discovered Inside Earth”

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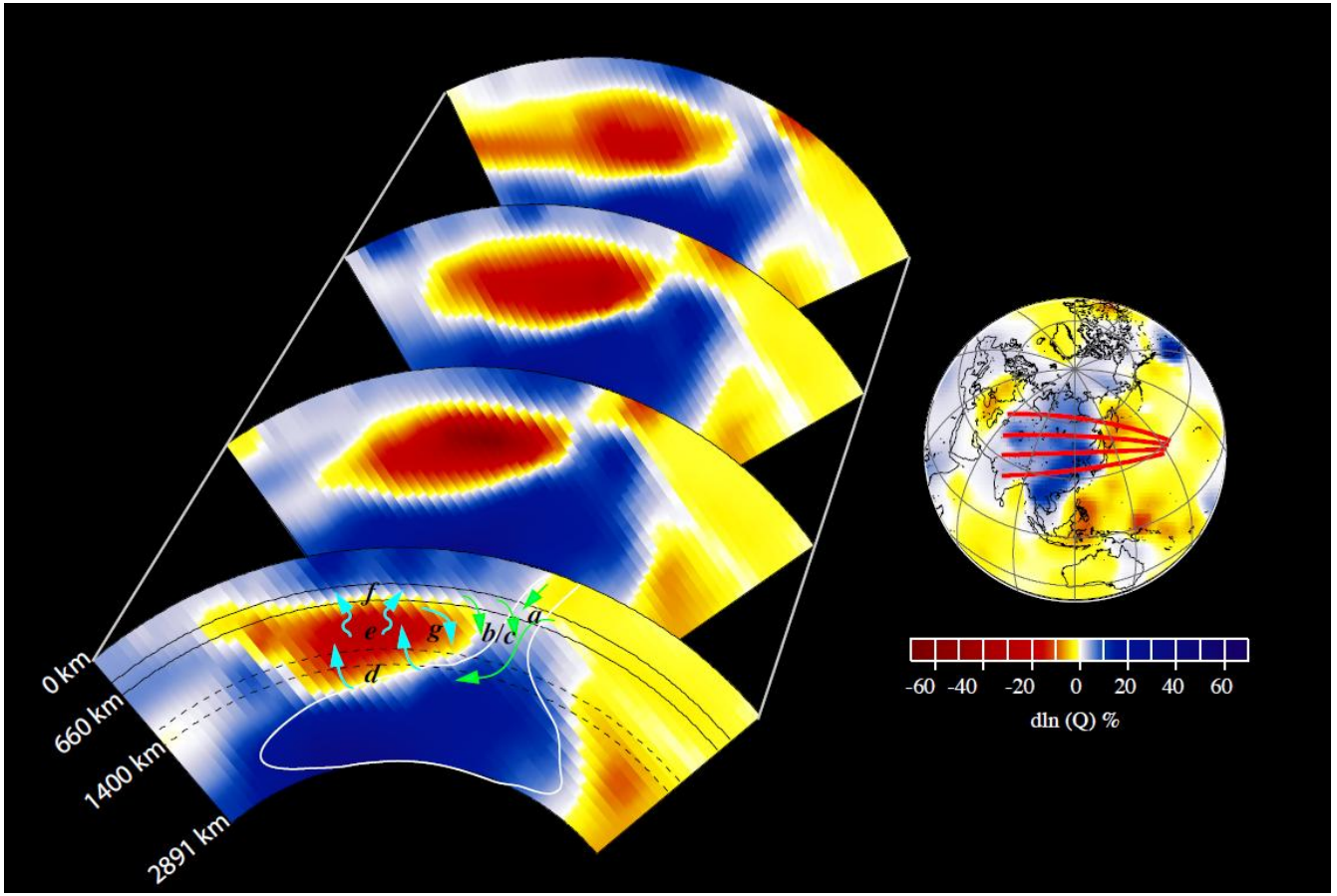
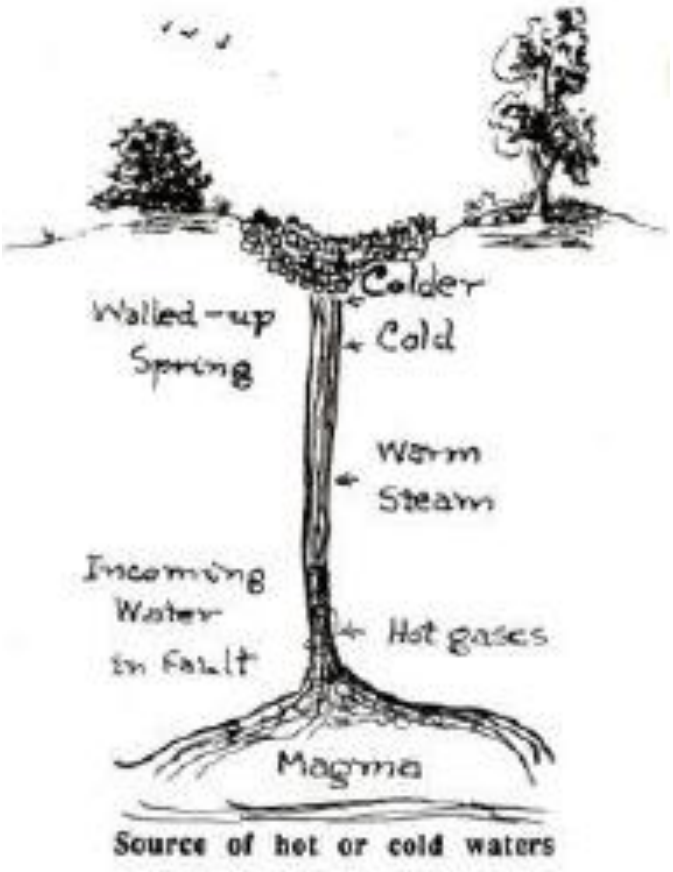
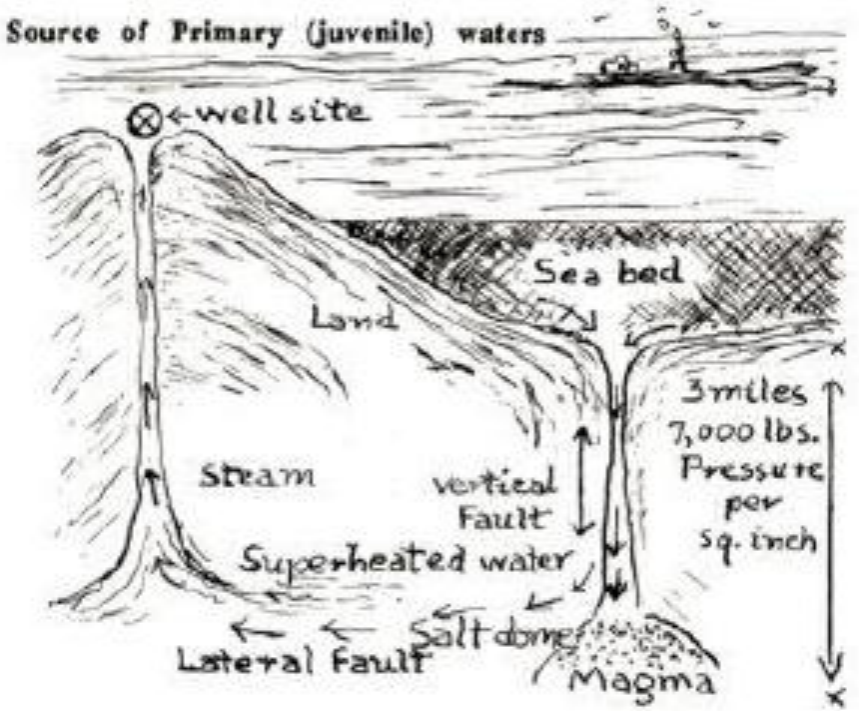


Oxygen Elevator?

- Concept drawing: Verne Cameron, **1960s**





“Slab Of Sunken Ocean Floor Found Deep Within Earth”

http://www.sciencedaily.com/releases/2006/06/060603092903.htm

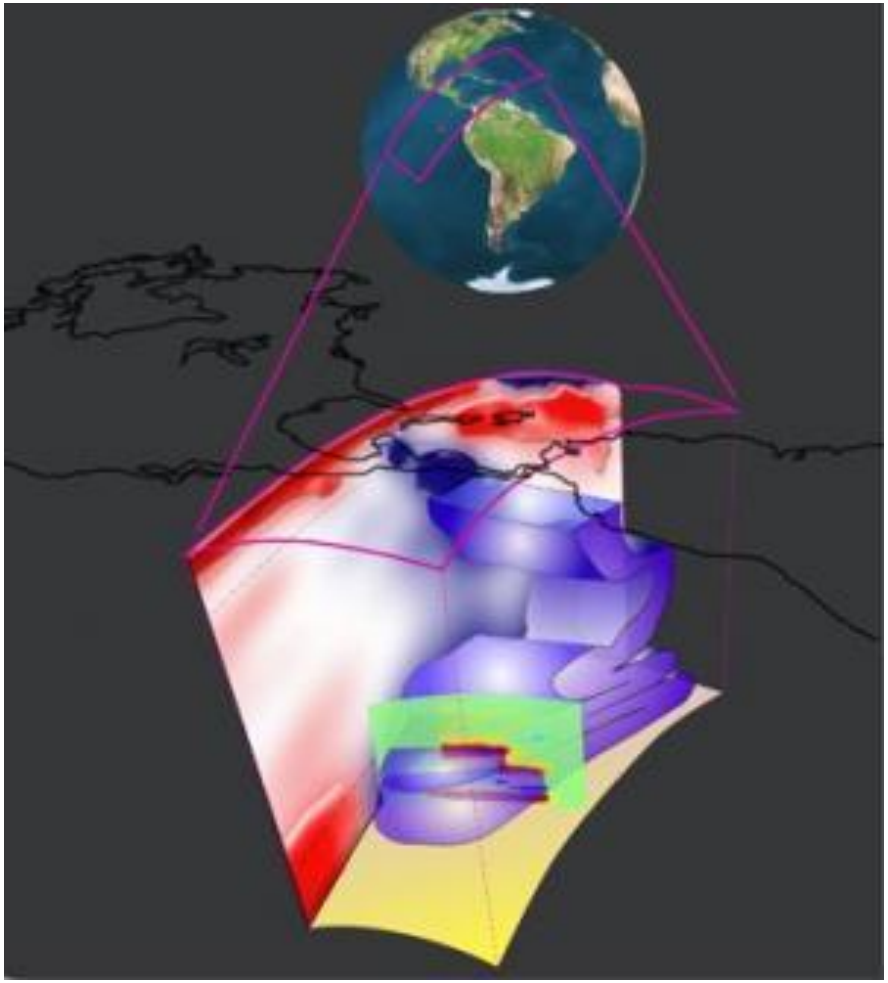
Abstract **(2006)**

Hutko, Lay, Garnero, Revenaugh

“Deep within Earth, **halfway to its center in an area where Earth's core meets its mantle**, lies a massive folded slab of rock that once was the ocean floor…

“**The discovery supports the theory that Earth's crust is constantly recycled deep into the planet** as molten material from below simultaneously pushes up to refresh the surface.” LiveScience - 2009

“Slab Of Sunken Ocean Floor Found Deep Within Earth”



"Life-giving rocks from a depth of 250 km"

http://www.nature.com/nature/journal/v449/n7161/full/nature06183.html

Abstract (**2007**)

Rohrbach, Ballhaus, Golla–Schindler, Ulmer, Kamenetsky and Kuzmin

"**If our planet did not have the ability to store oxygen in the deep reaches of its mantle there would probably be no life on its surface.** This is the conclusion reached by scientists at the University of Bonn…. The proverbial "solid ground" under our feet is actually in constant flux. **At the boundaries between the tectonic plates in what are called the subduction zones this seemingly solid ground is drawn down many hundreds of kilometres into the hot interior. As the material descends it takes with it oxygen**, which is bound as iron oxide in the earth's mantle, oxygen that derives from the dim distant beginnings of the universe. **In particular, the earth constantly exudes hydrogen, which combines with this oxygen to form water.** Without the **'oxygen elevator'** in its mantle the earth would probably be a barren planet hostile to life."

"Oldest Water on Earth Found Deep Underground"

http://www.nature.com/nature/journal/v497/n7449/full/nature12127.html

Nature (**2013**)

G. Holland, B. Sherwood Lollar, L. Li, G. Lacrampe-Couloume, et al.

"**Fluids trapped as inclusions within minerals can be billions of years old and preserve a record of the fluid chemistry and environment at the time of mineralization.** Expulsion of fracture fluids from basement systems with low connectivity occurs through deformation and fracturing of the brittle crust. The fractal nature of this process must, at some scale, preserve pockets of interconnected fluid from the earliest crustal history. **Further evidence of an ancient fluid system is found in [isotope] 129Xe excesses** that, owing to the absence of any identifiable mantle input, are probably sourced in sediments and extracted by fluid migration processes operating during or shortly after mineralization at around 2.64 billion years ago… **Together, the different noble gases show that ancient pockets of water can survive the crustal fracturing process and remain in the crust for billions of years.**"

"Scientists Detect Magmatic Water on Moon's Surface"

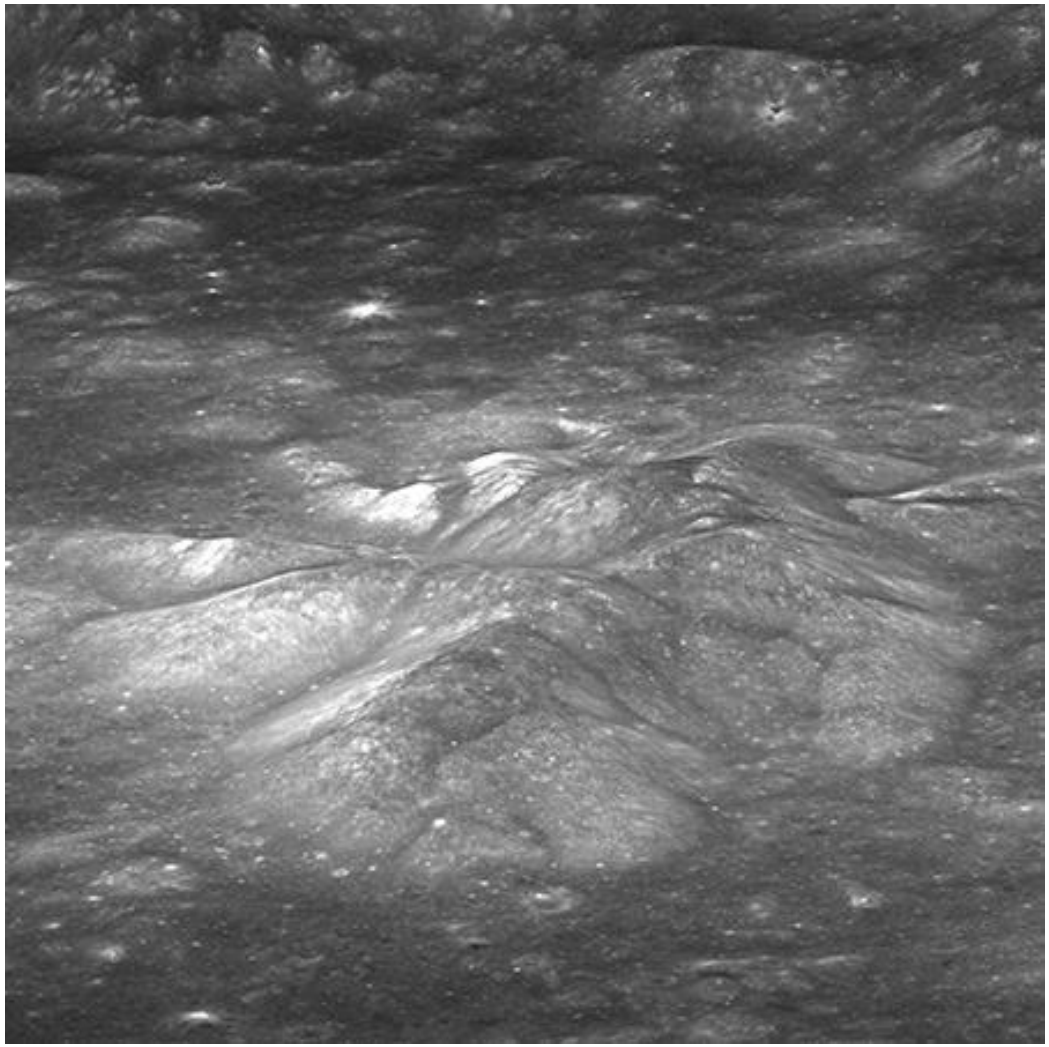
http://www.jhuapl.edu/newscenter/pressreleases/2013/130826.asp

University of Johns Hopkins, Applied Physics Lab (**2013**)

Klima (APL), Hagerty (NASA), Cahill (APL) and Lawrence (APL)

"Scientists have detected magmatic water — **water that originates from deep within the Moon's interior** — on the surface of the Moon. 'About five years ago, new laboratory techniques used to investigate lunar samples revealed that **the interior of the Moon is not as dry as we previously thought**… The rocks in the central peak of the crater are of a type called **norite that usually crystallizes when magma ascends but gets trapped underground** instead of erupting at the surface as lava... **The internal magmatic water provides information about the Moon's volcanic processes and internal composition**,' Klima said. Understanding this internal composition helps us address questions about **how the Moon formed, and how magmatic processes changed as it cooled**.' "

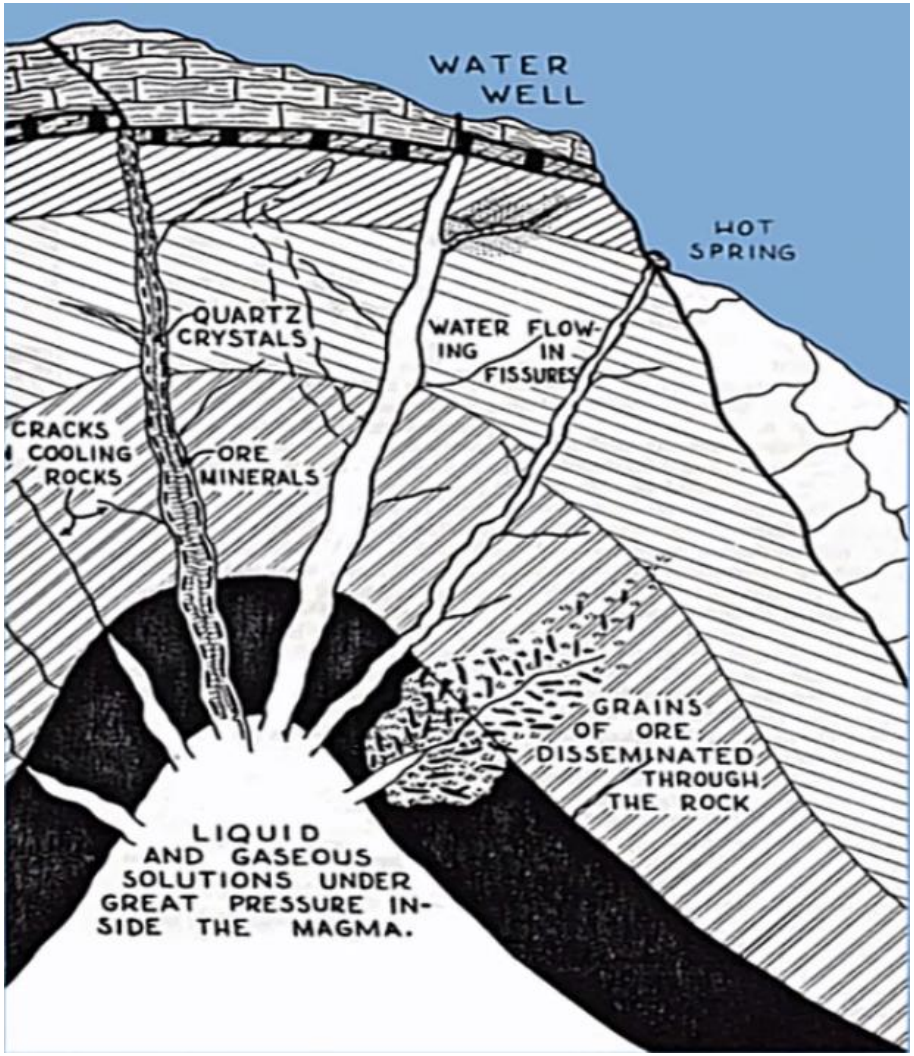
“Scientists Detect Magmatic Water on Moon's Surface”



Magmatic and Crystalline HHO

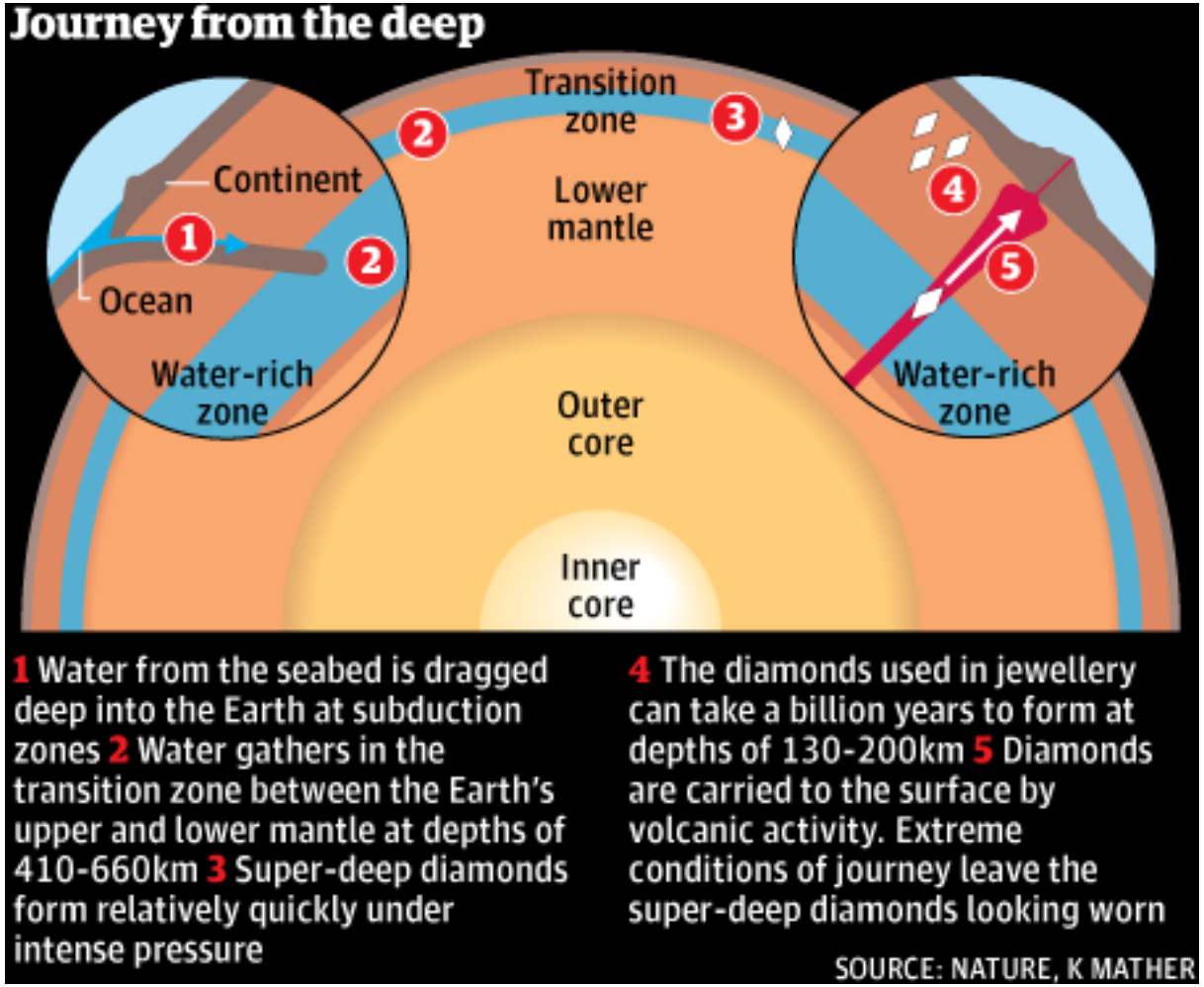
- Hypogene (https://en.wikipedia.org/wiki/)
  - In ore deposit geology, hypogene processes occur deep below the earth's surface, and tend to form deposits of **primary minerals**, as opposed to supergene processes that occur at or near the surface, and tend to form secondary minerals.[1]
  - **At great depth the pressure is high, and water can remain liquid at temperatures well above 100 °C.** Hot aqueous solutions originating in the magma contain metal and other ions derived from the magma itself, and also from leaching of surrounding rocks. Hypogene deposition processes include **crystallization from the hot aqueous solutions rising through the earth's crust**, driven by heat provided by the magma.[2]
  - As the solutions rise the temperature and pressure fall. Eventually a point is reached where the minerals start to crystallize out.[2] **Minerals formed in this way are called primary, or hypogene, minerals.**

Conceptual Drawing (Dr. Bickel: 1960s)



“Rough diamond hints at vast quantities of water inside Earth”

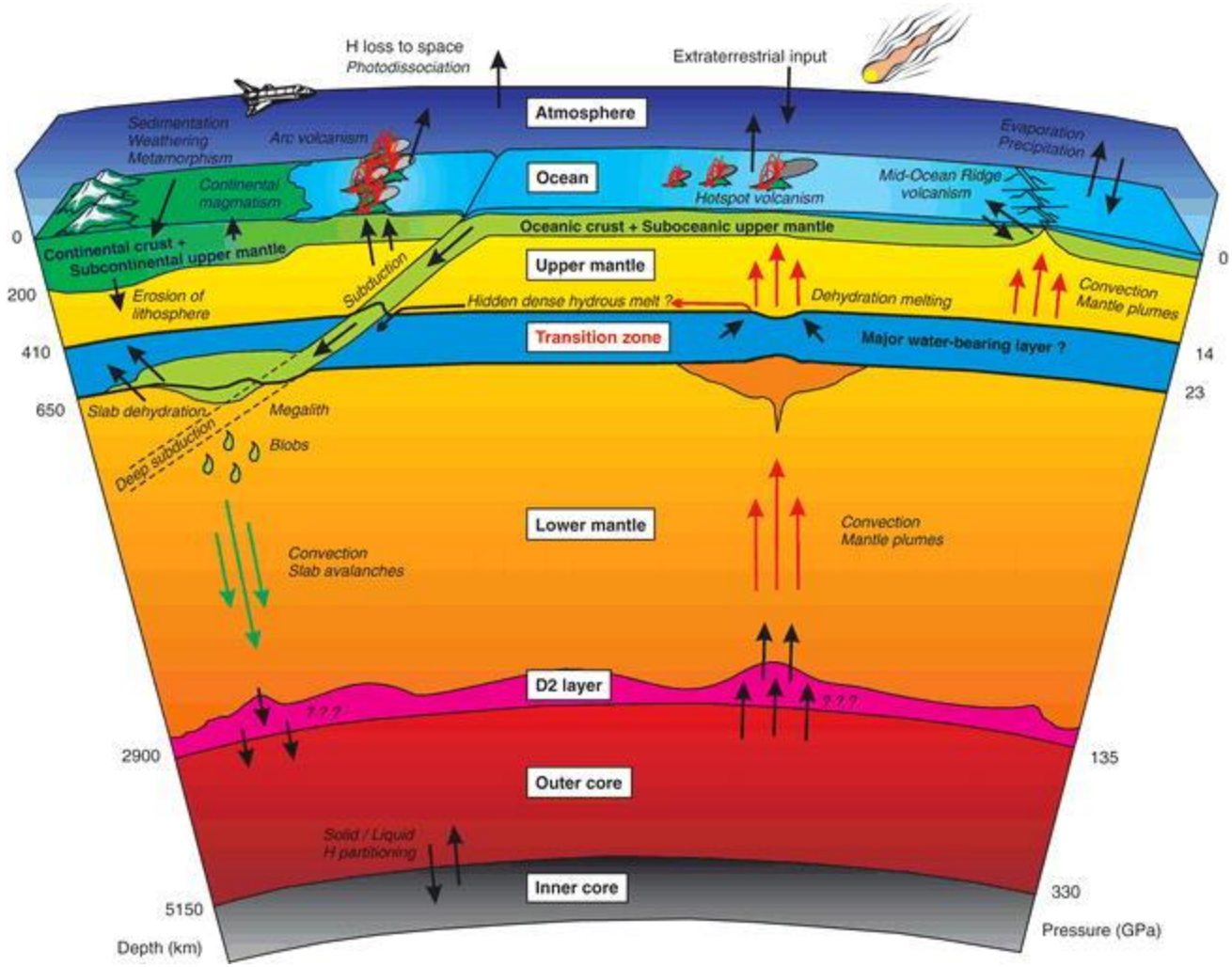
http://www.theguardian.com/science/2014/mar/12/rough-diamond-water-earth-wet-zone



“Hydrous mantle transition zone indicated by ringwoodite included within diamond”

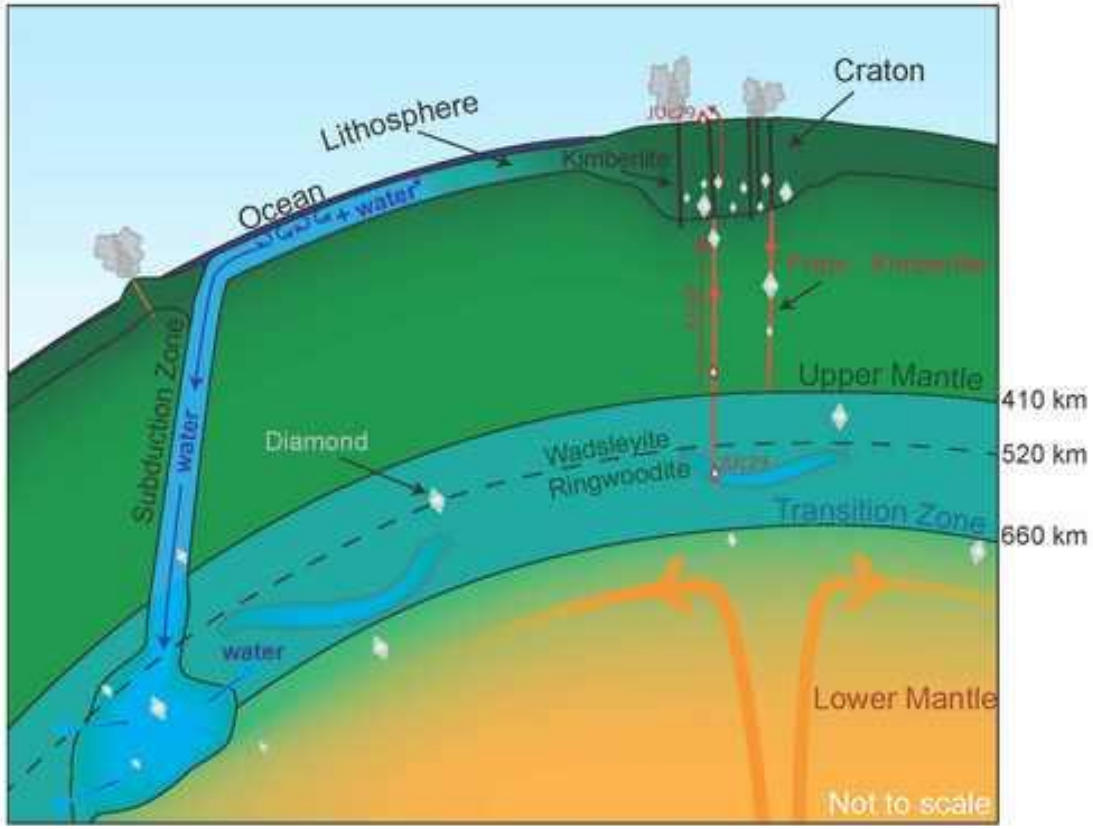
Nature 507, 221–224 (13 March 2014): G. Pearson, Metveev, Brenker, Nestola, et al.

“The ultimate origin of water in the Earth’s hydrosphere is in the deep Earth—the mantle.”



“Rare Diamond Reveals Earth's Interior is All Wet”

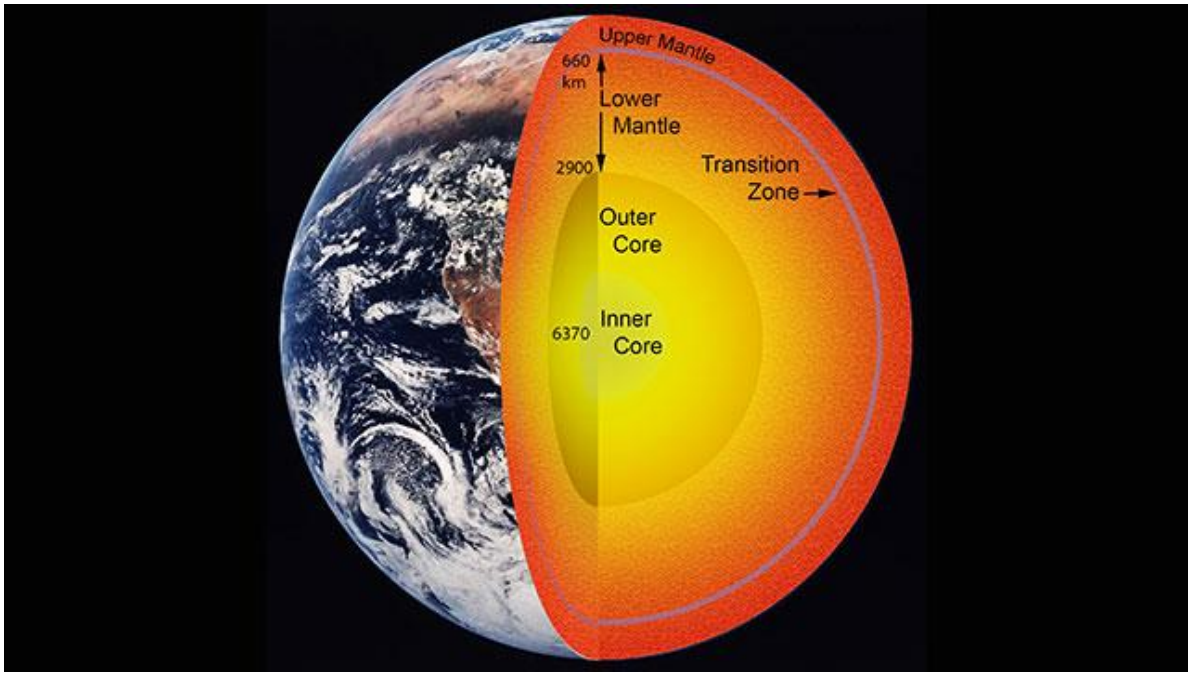
http://www.livescience.com/44057-diamond-inclusions-mantle-water-earth.html



“NEW EVIDENCE FOR OCEANS OF WATER DEEP IN THE EARTH

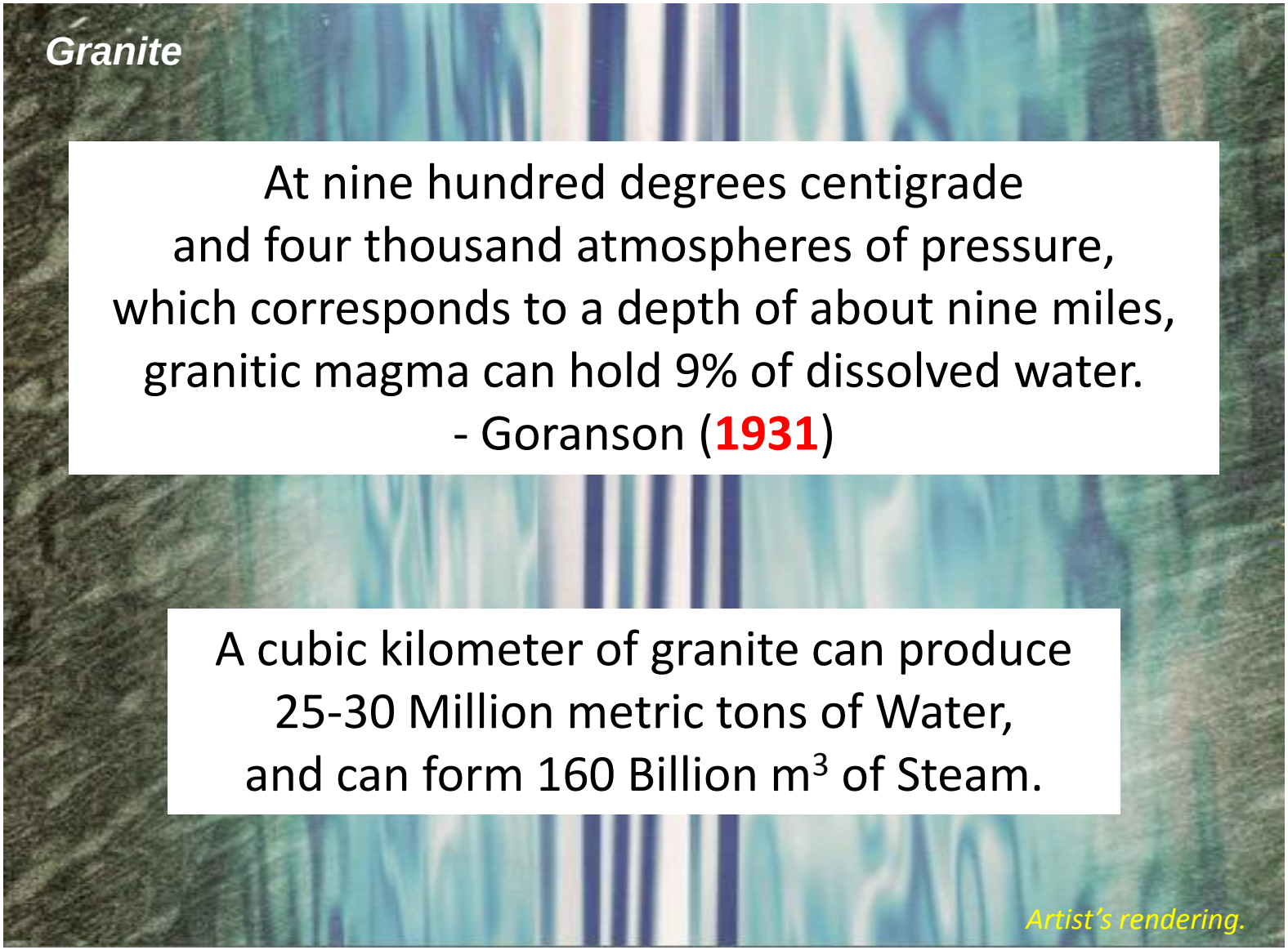
Water bound in mantle rock alters our view of the Earth’s composition”

http://www.livescience.com/44057-diamond-inclusions-mantle-water-earth.html



EVANSTON, Ill. --- Researchers from Northwestern University and the University of New Mexico report evidence for potentially oceans worth of water deep beneath the United States. ***Though not in the familiar liquid form -- the ingredients for water are bound up in rock deep in the Earth’s mantle -- the discovery may represent the planet’s largest water reservoir.***

Water from Rock



At nine hundred degrees centigrade
and four thousand atmospheres of pressure,
which corresponds to a depth of about nine miles,
granitic magma can hold 9% of dissolved water.
- Goranson (**1931**)

A cubic kilometer of granite can produce
25-30 Million metric tons of Water,
and can form 160 Billion m^3 of Steam.

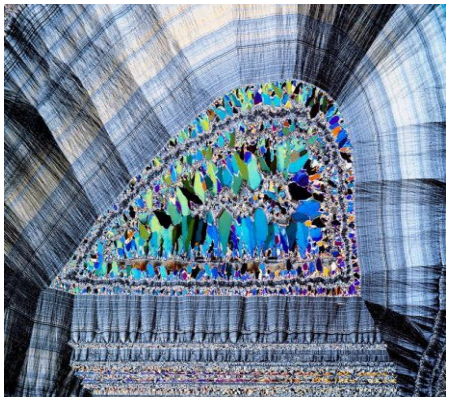
Artist's rendering.

“Planet Earth makes its own water from scratch deep in the mantle”

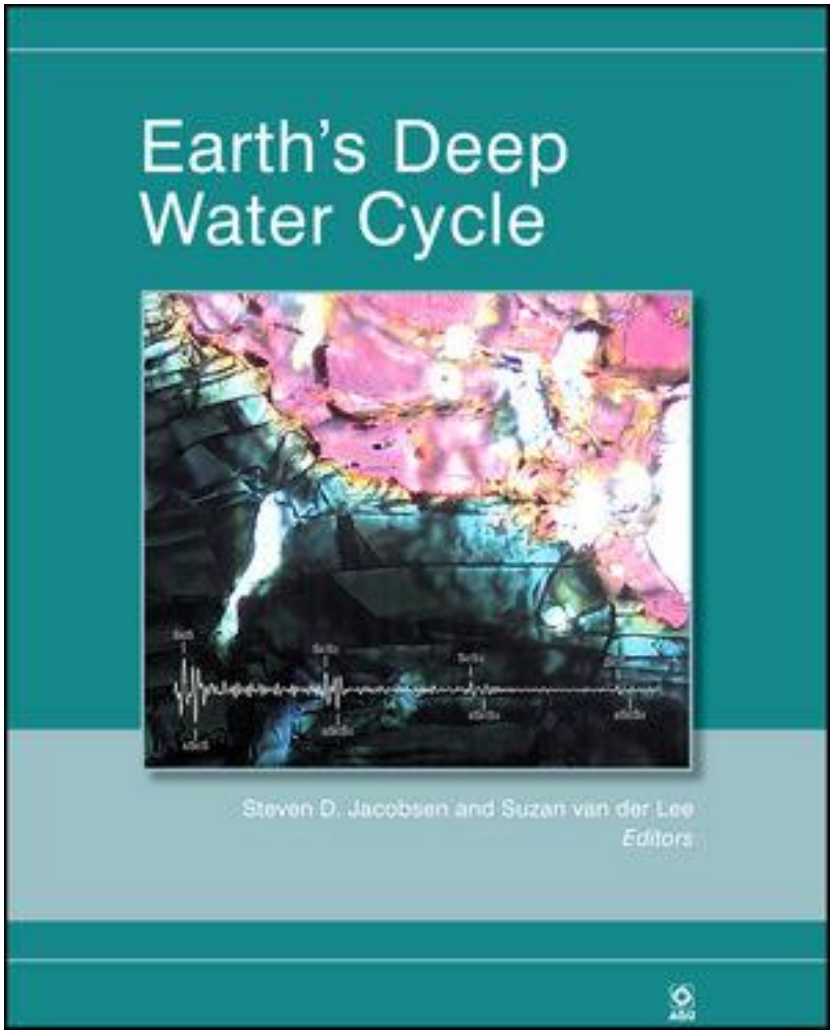
https://www.newscientist.com/article/2119475-planet-earth-makes-its-own-water-from-scratch-deep-in-the-mantle/
(**2017**)

Zdenek Futera, Xue Yong, Yuanming Pan, John S. Tse, Niall J. English

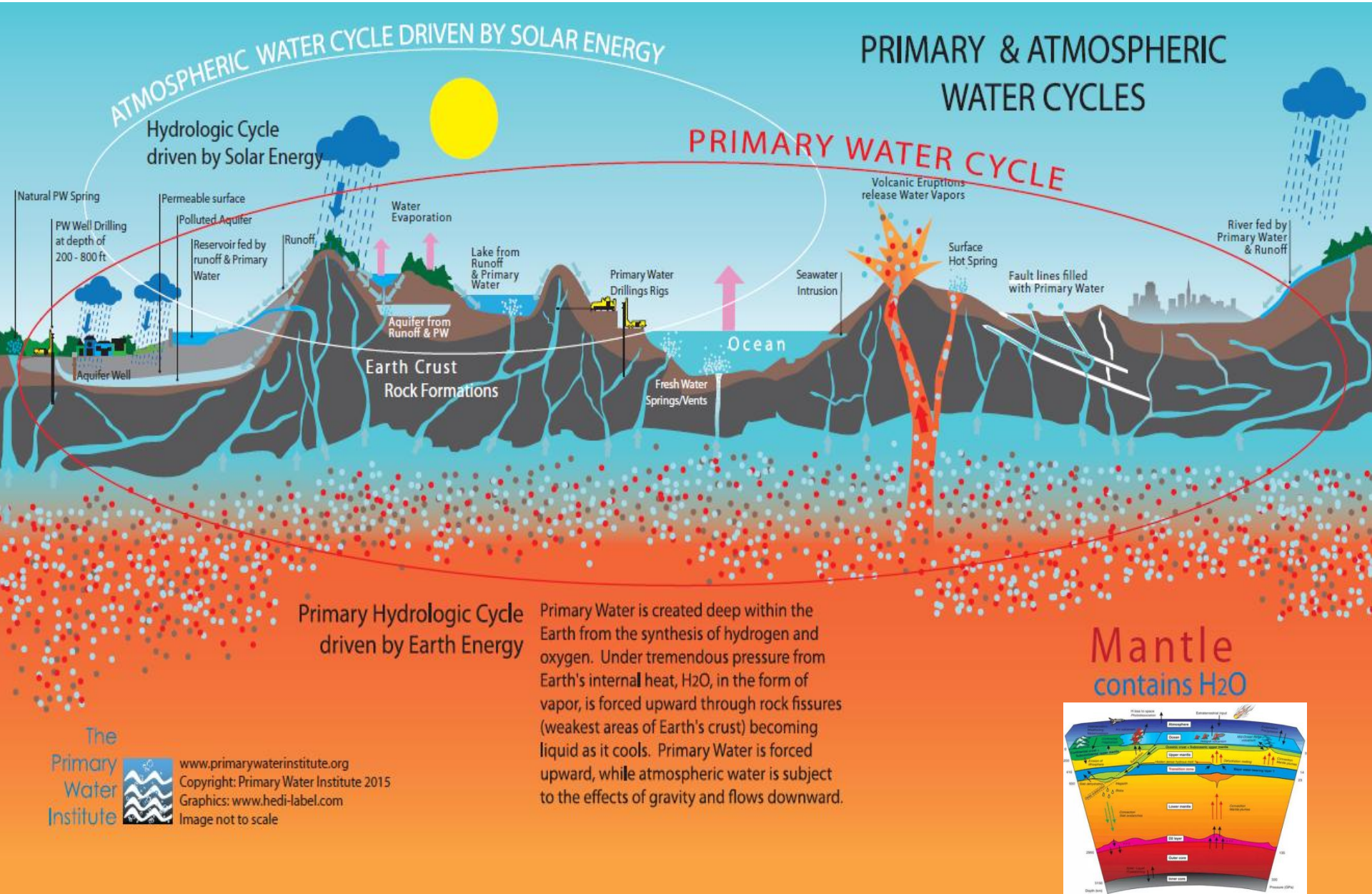
*“This is one way water can form on Earth,” says team member John Tse at the University of Saskatchewan in Canada. “**We show it’s possible to have water forming in Earth’s natural environment, rather than being of extraterrestrial origin.**” The simple reaction takes place at about C 1400 ° and pressures 20,000 times higher than atmospheric pressure as **silica, or silicon dioxide, reacts with liquid hydrogen to form liquid water and silicon hydride**. The latest work simulates this reaction under various temperatures and pressures typical of the upper mantle between 40 and 400 kilometres down. **It backs up previous work by Japanese researchers who performed and reported the reaction itself in 2014.**”*



Further Scientific Reading

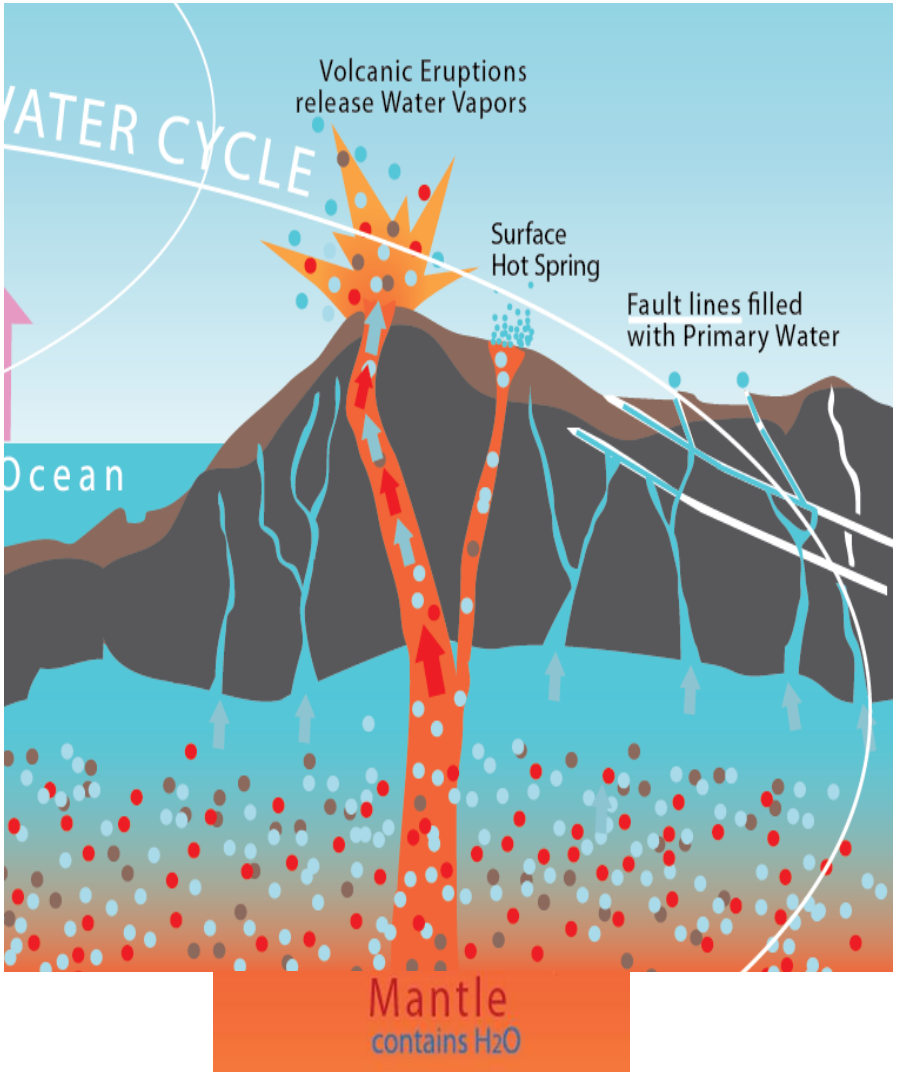


Primary Water Cycle vs. Atmospheric Cycle

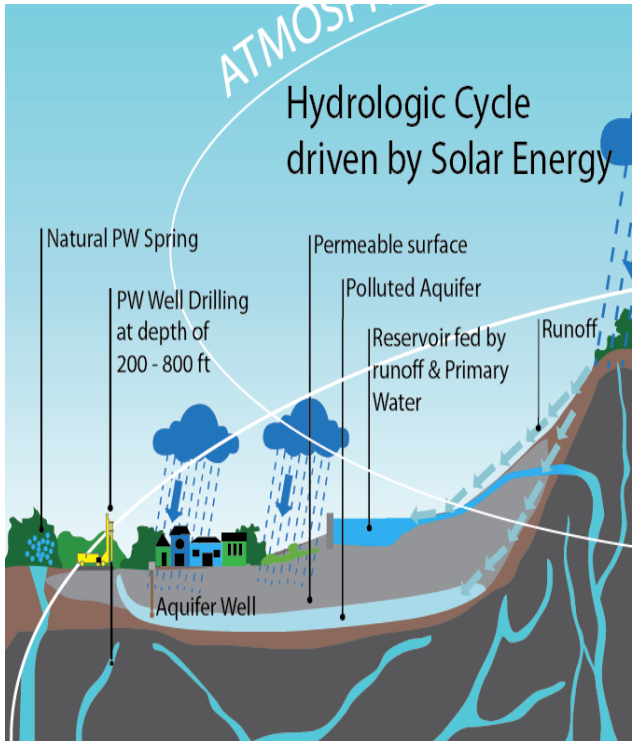


Origin of Primary Water

- H_20 in the form of vapor is forced up through the weakest areas of earth's crust, the rock fissures, and it becomes liquid as it cools
- The mantle of the earth contains large quantities of H_2O. Primary water is present in various sources:
  - Metamorphic water, freed by natural transmutation from rock formations under very high pressure
  - Magmatic and volcanic water, by the synthesis of hydrogen and oxygen under tremendous pressure from the earth's internal heat
  - Oceanic water, caused by subduction of tectonic plates and recycled into the shallow mantle
- Water in supercritical state also transports heavy metals that become sources of primary deposits of ore (mostly in veins) aka hypogene processes



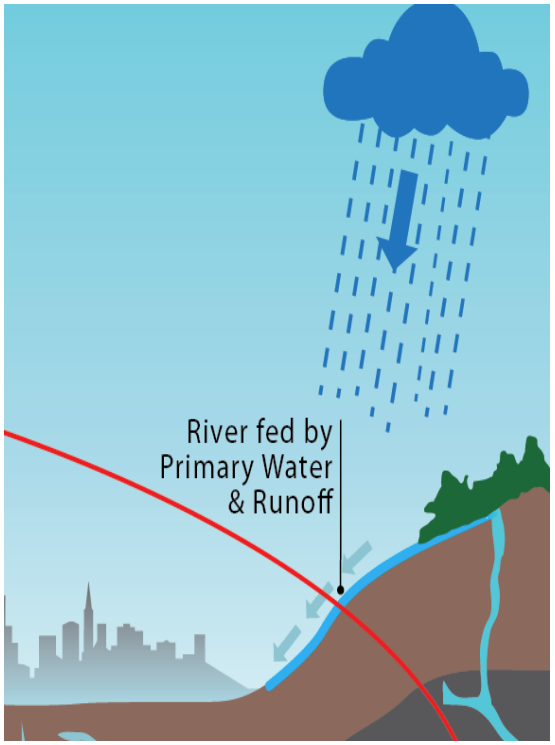
Boundaries & Linkages



Atmospheric water cycle

Non-permeable layer

Primary water cycle system



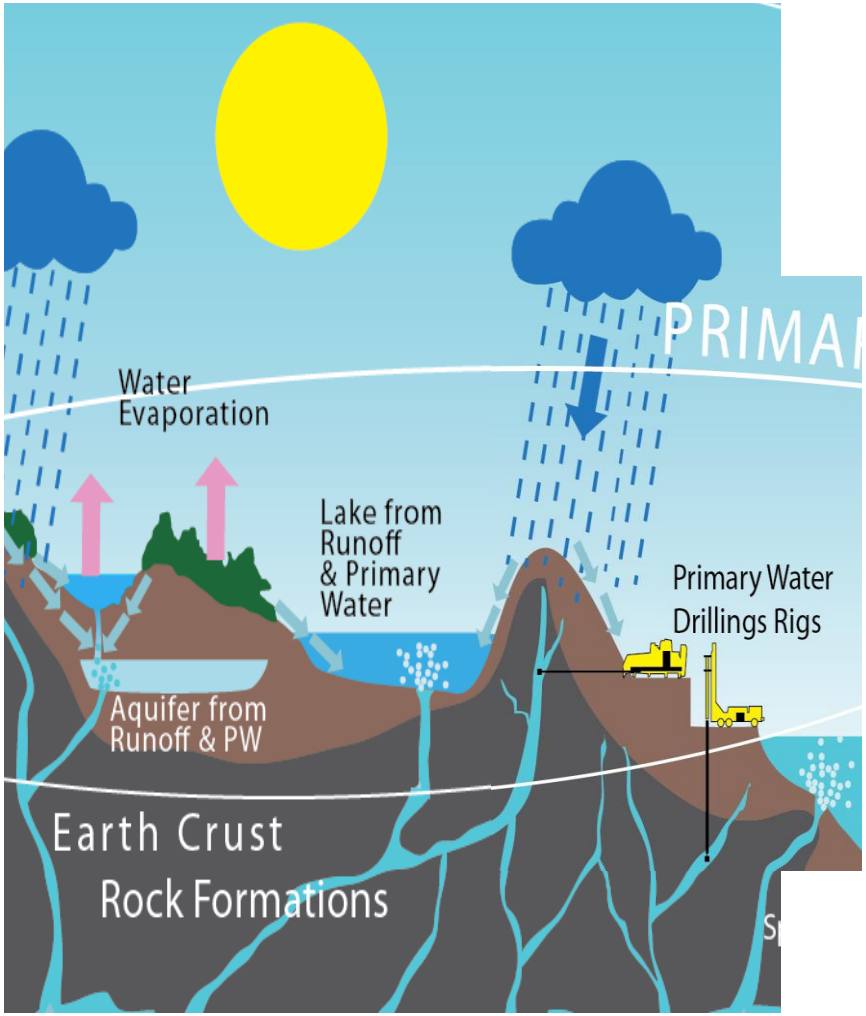
- The hydrologic (secondary) cycle includes precipitation, runoffs, reservoirs, groundwater bodies (aquifers), infiltration, seepage, evaporation and transpiration
- Permeable ground is comprised of unsorted material (crushed gravel, sands, soil) typical of unconsolidated formations
- Any aquifer that is trapped beneath this permeable material is subject to contamination because of the presence of activity at the surface

- A primary water spring often manifests on top of a mountain co-mingling with run-off rain water

$$\delta^{18}O = \left(\frac{\left(\frac{^{18}O}{^{16}O}\right)_{sample}}{\left(\frac{^{18}O}{^{16}O}\right)_{standard}} - 1 \right) * 1000\ {}^{o}/_{oo}$$

How to access Primary Water

- Primary water rises from the mantle via the faults, fractures and fissures of the crust where it recharges rainfed aquifers, many lakes and the oceans
- In many locations primary water is constantly adding to the hydrosphere
- In other places, primary water fissures do not reach the surface
- Drilling rigs can access those subterranean primary water sources by drilling horizontally or even vertically into the fracture zone or fissure
- **It is our mission to locate and access primary water fissures with high yields worldwide to end water scarcity now!**



Primary Water “E&P”

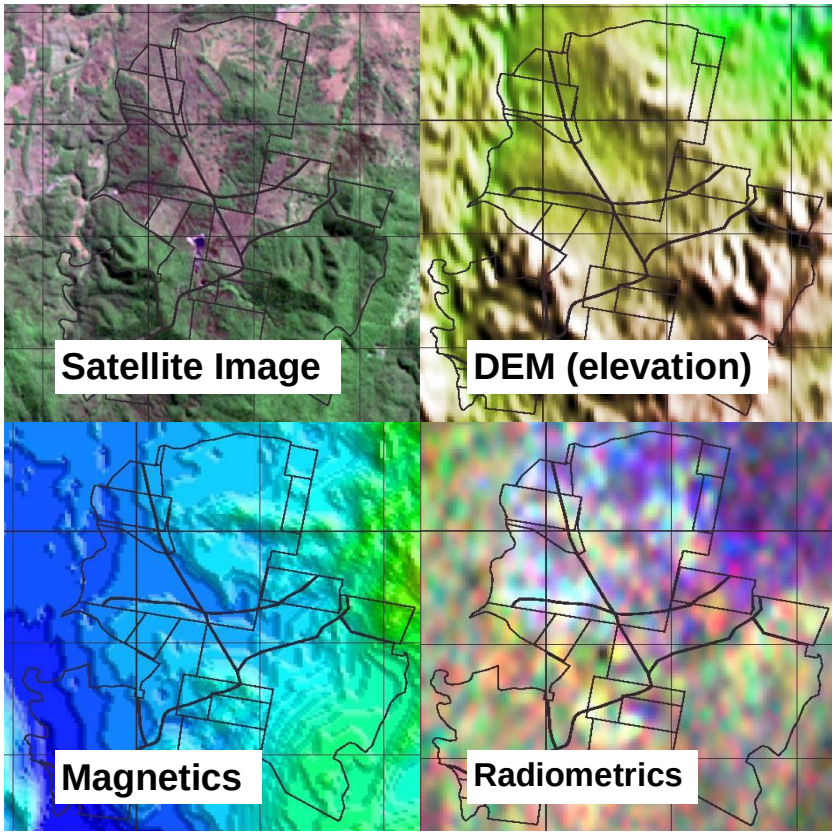
- E&P = Exploration and Production
- Normally used with oil/gas or minerals and mining
- Similar approach can be taken to explore, locate and drill for earth-generated Primary Water
- Advanced remote sensing and geophysical data analytics can be employed
- Rapid field survey techniques pinpoint the locations
- Resulting in **highly accurate predictions of depth, volume and quality**
- **These wells are continuous-flow with no relation to rainfall, seasonality or drought**

Remote Sensing

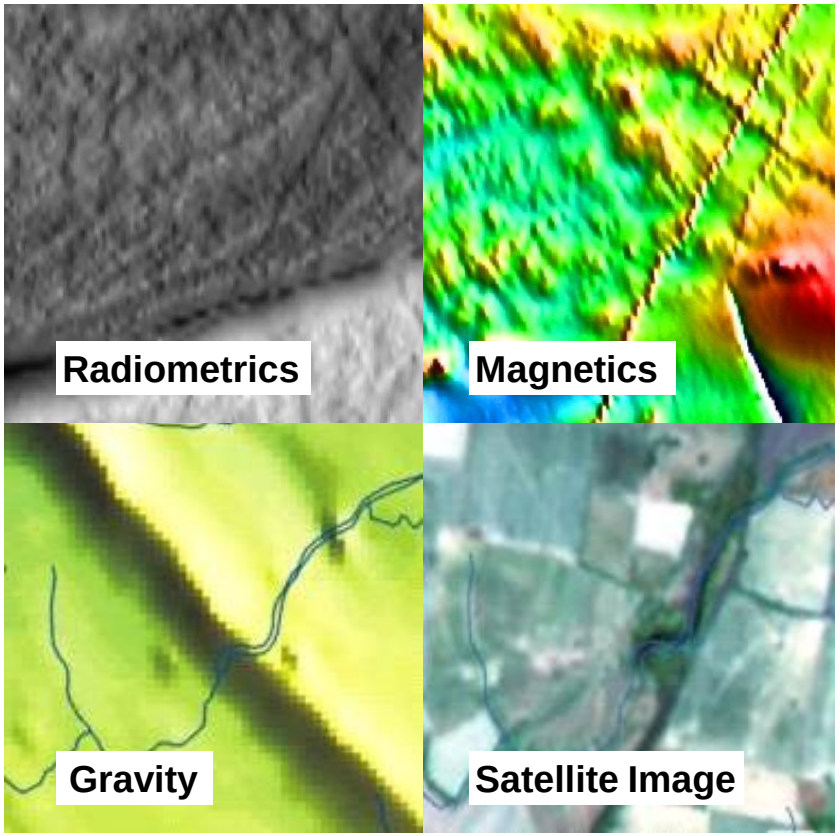
- PWT has multiple teaming partners who utilize **modern survey techniques** and proprietary **geophysical data analytics** using:
  - Satellite (DEM, spectral, radar…)
  - Magnetics (geo-mag)
  - Gravity
  - Radiometrics (gamma ray spectrometry)
  - Passive seismics

Satellite Imagery and Data Analytics

- Geophysical imagery:



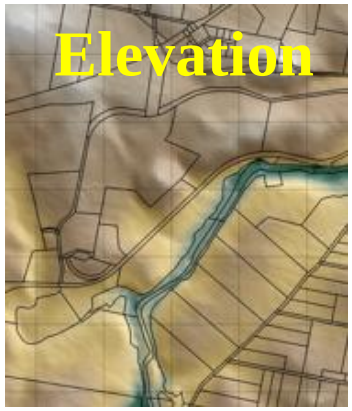
- Enhanced to highlight structures:

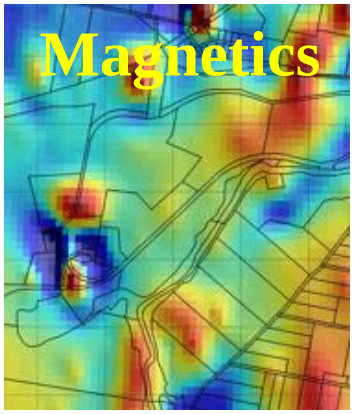


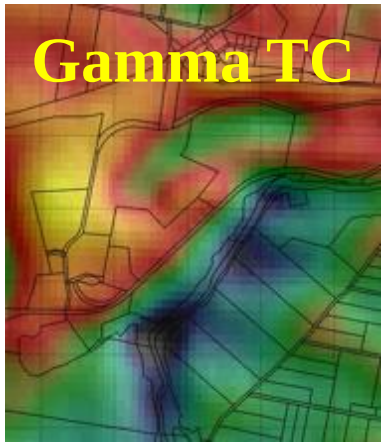
Ref: Orbtek - Australia

Classification

- Groundwater Data Sets:







Ref: Orbtek - Australia

Australia: Young NSW

- Borehole producing 250,000 liters/hour (1000 gpm)

Ref: Orbtek - Australia

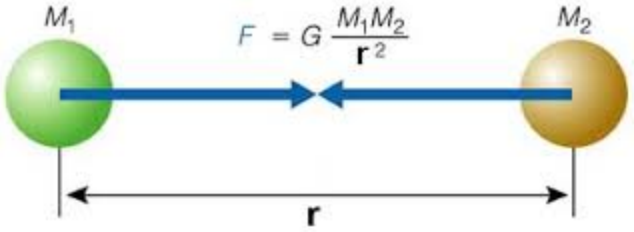
Australia: Junee NSW

- Bore near Junee, NSW produces 54,000L per hour (250 gpm). Drilled through 330m of granite and struck a fine brickies sand.
- This is the largest producing bore in the area. **The volume and depths to primary water were accurately predicted.**

Ref: Orbtek - Australia

Geophysical Data

- We are most interested in <u>passive data</u> collection:
  - Magnetics and Gravity
    - Provide clues to rock density and rock composition

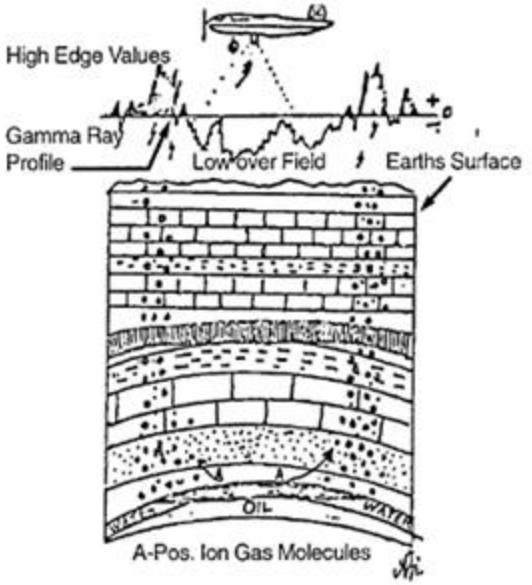


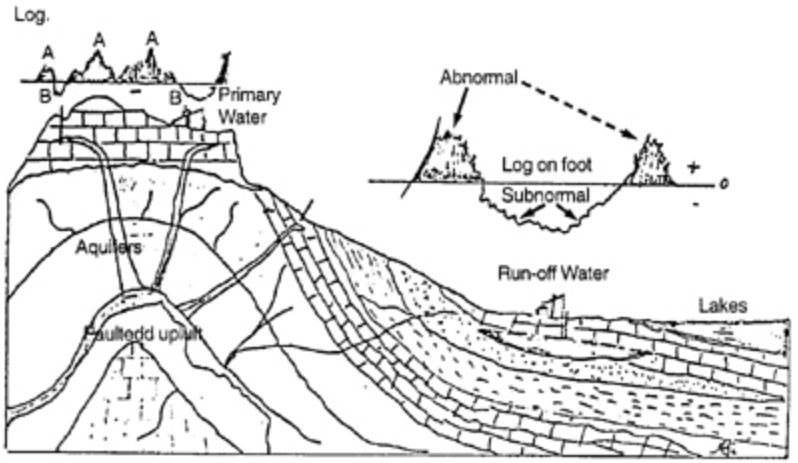
  - **Radiometrics (gamma ray spectrometry)**
  - **Passive Seismics**

Radiometrics

- Gamma ray spectrometry
  - Pioneered by Dr. Armin Bickel of NASA
  - Gamma can be used to locate oil, gas, minerals **and H_2O**
  - Numerous German scientists carry on Dr. Bickel's work

Dr. Bickel with his Algor Explorer: 1960s





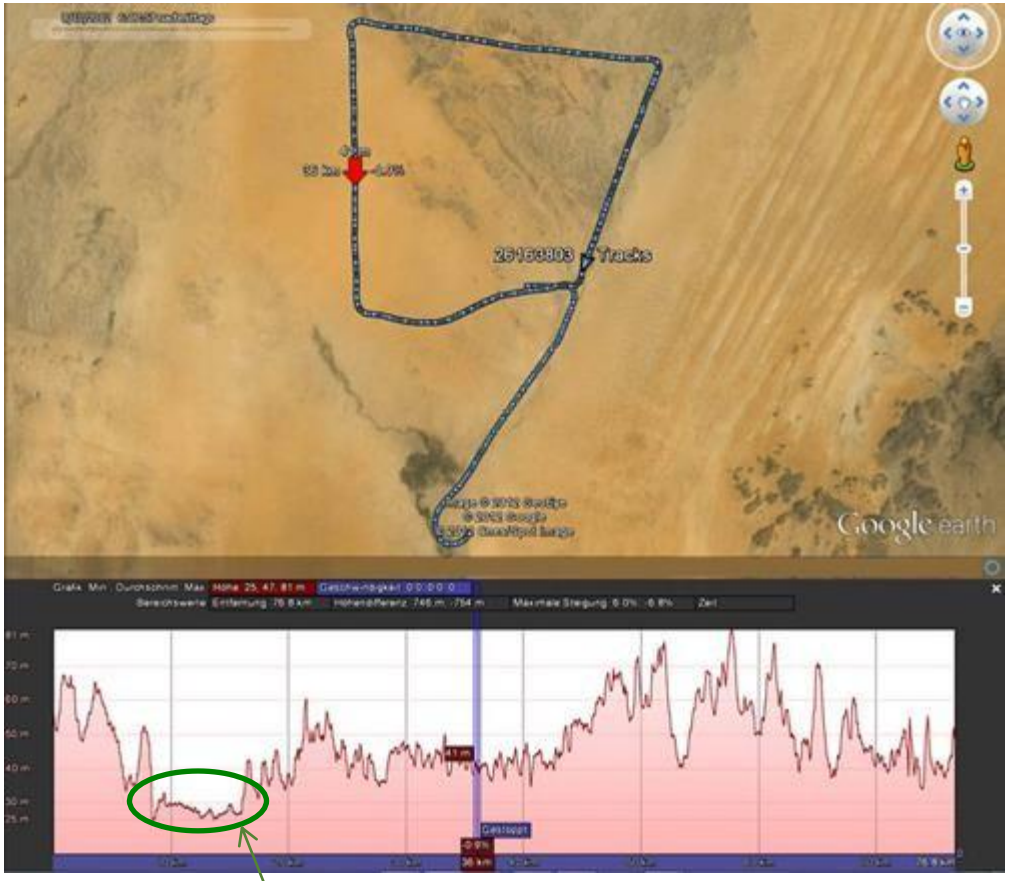
Ref: Transformative Technologies

Radiometrics: prospecting with scintillation gamma counters

- For more than 25 years our radiometric survey partner has been working with modified scintillation counters as geo-physical measuring devices. As such they are capable of examining areas of any size, non-destructively, accurately and in a short period of time.

- Proprietary scintillation counters work with a software that records both measured data and GPS coordinates in real time while walking, driving, or flying over survey areas (including via drone), thereby allowing accurate data processing.

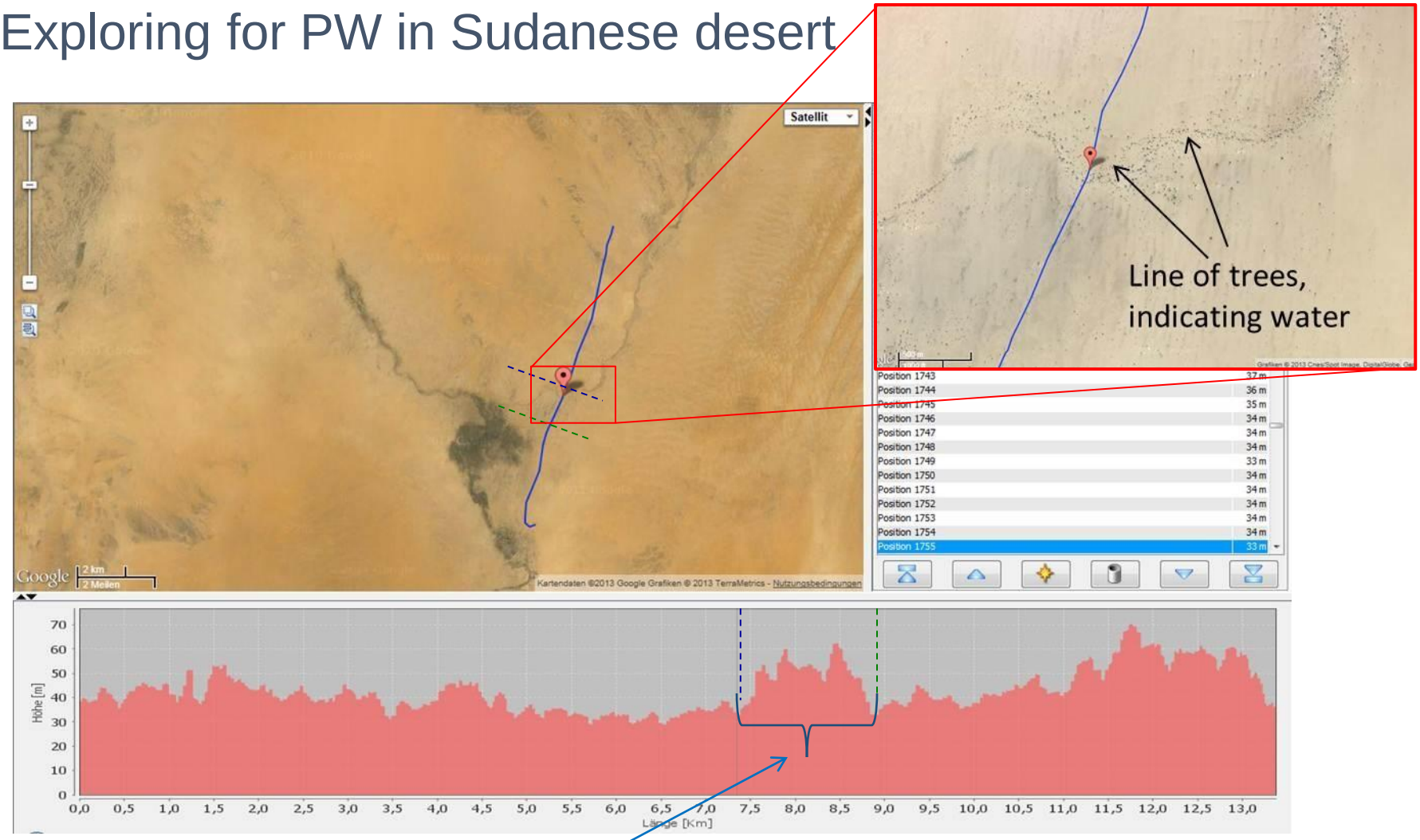
- Visualization of the surveys in Google Earth facilitates rapid interpretation of the results.



Sub-normal activity, indicating sub-surface water

Ref: Transformative Technologies

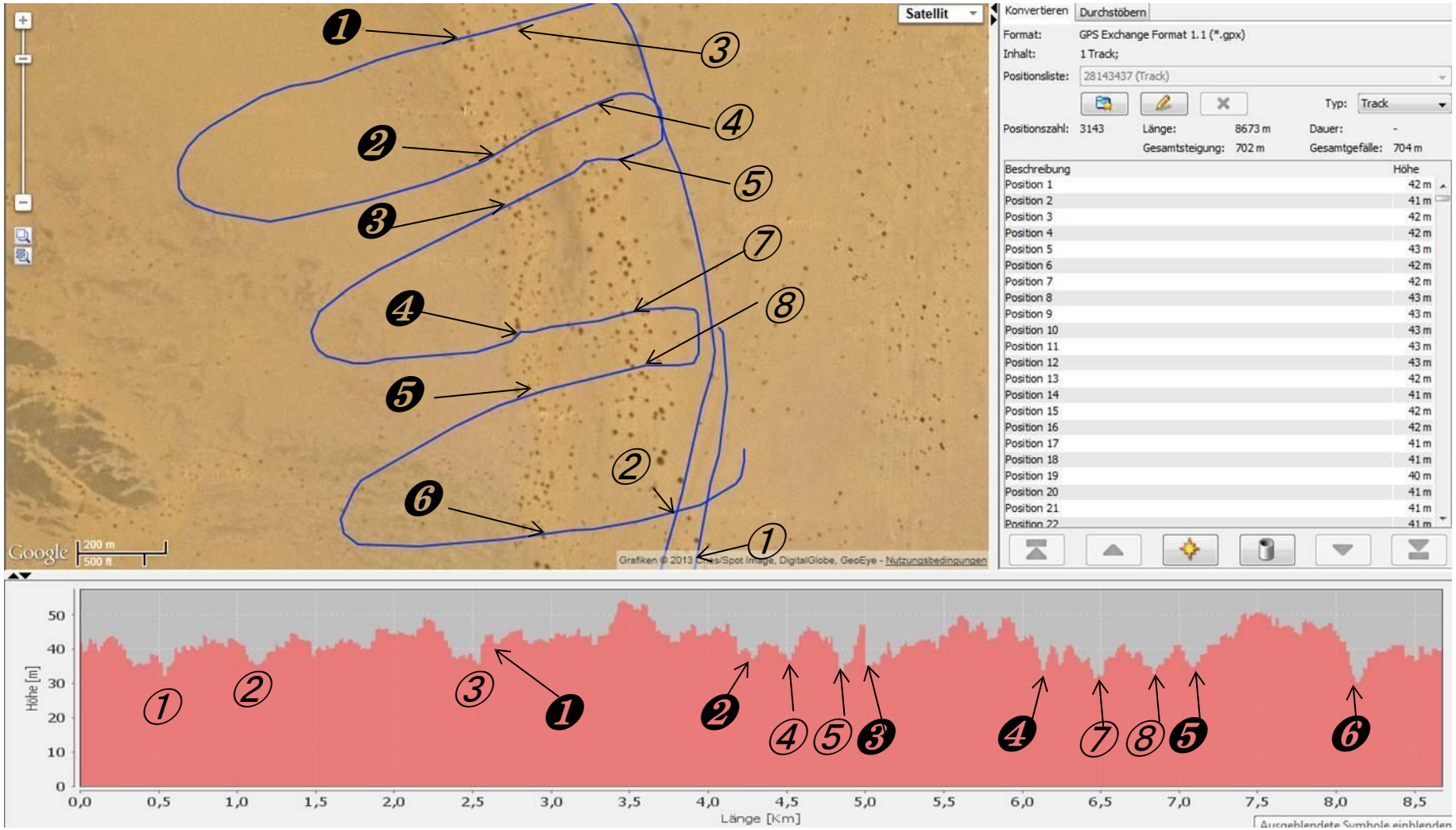
Exploring for PW in Sudanese desert



Sub-surface mountain range, redirecting the water flow

Ref: Transformative Technologies

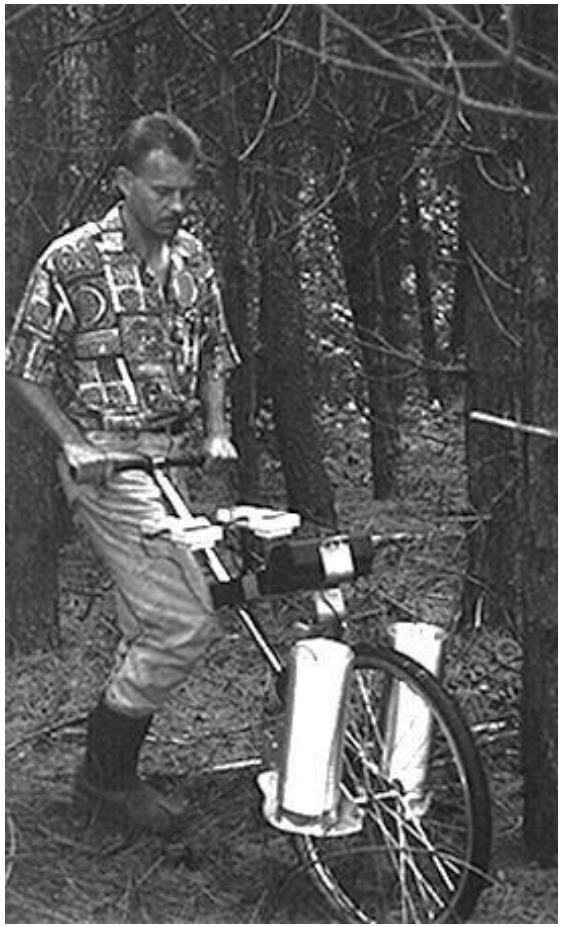
Exploring for PW in Sudanese desert, cont'd



Troughs indicate water, underground streams, hot spots

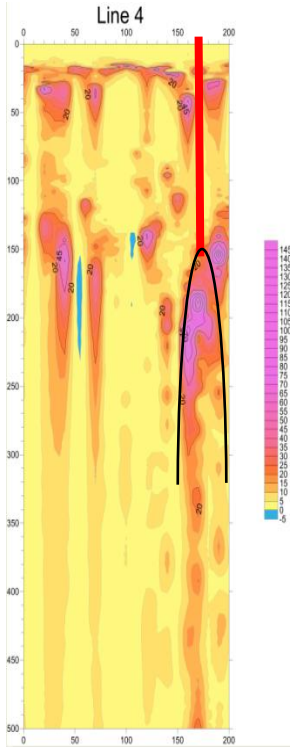
Survey Options

- Depending on the size of the area to be surveyed, the exploration can be carried out by foot, by hand cart, by 4-wheel-drive vehicle, or by helicopter; UAV/RPAS/drone is currently under design.

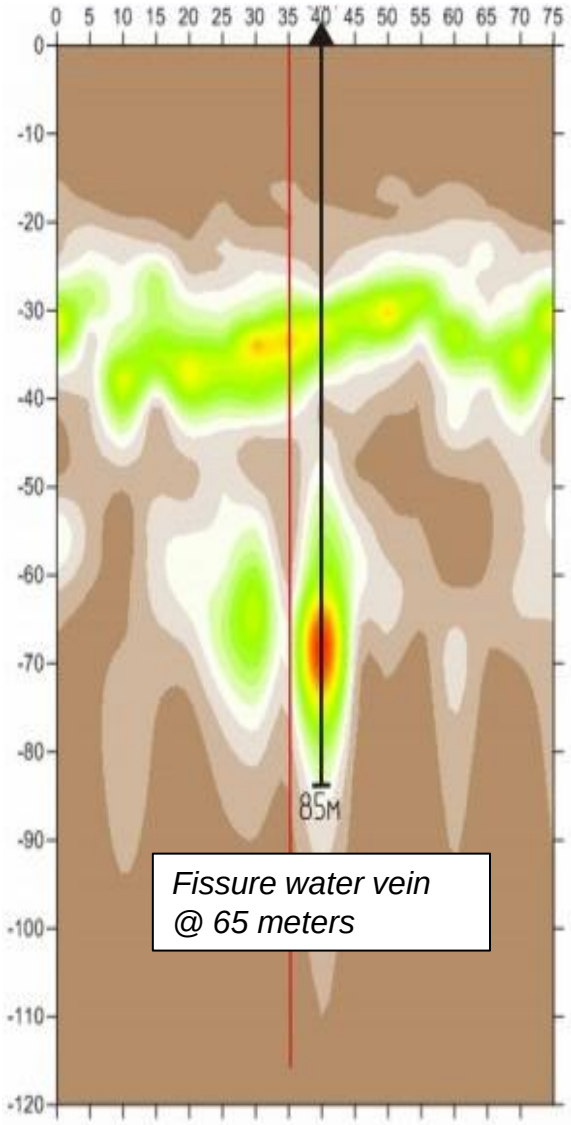


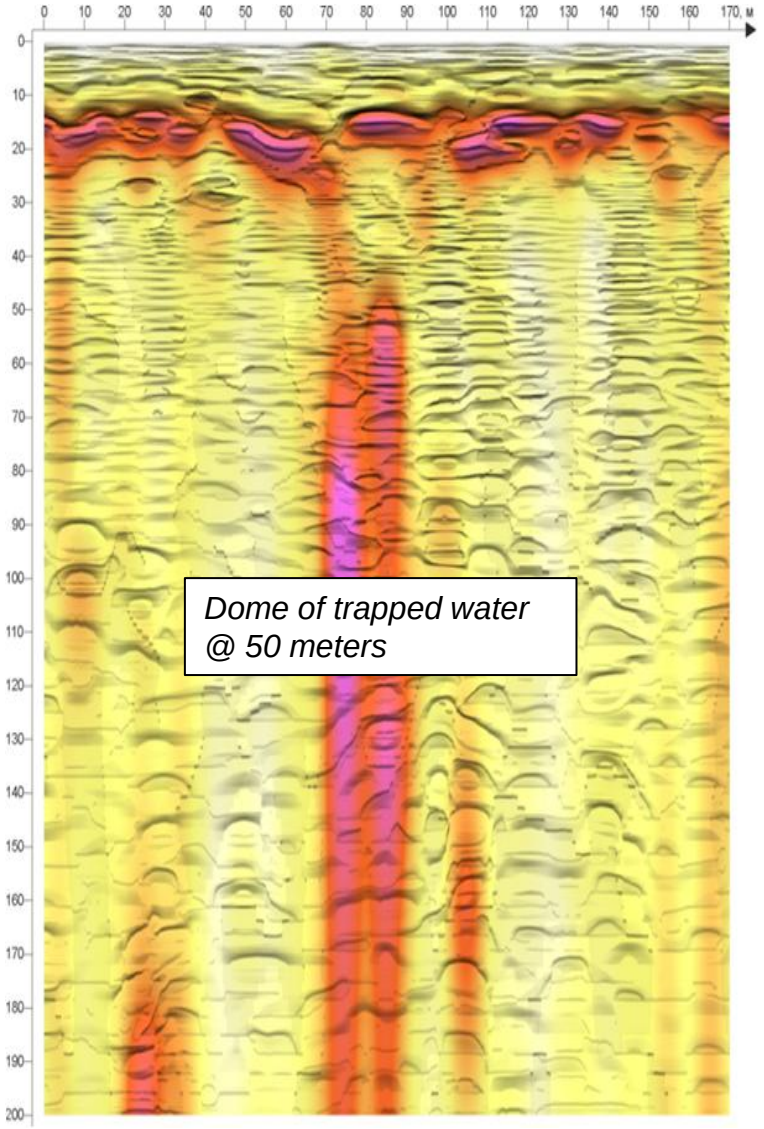
Passive Seismics

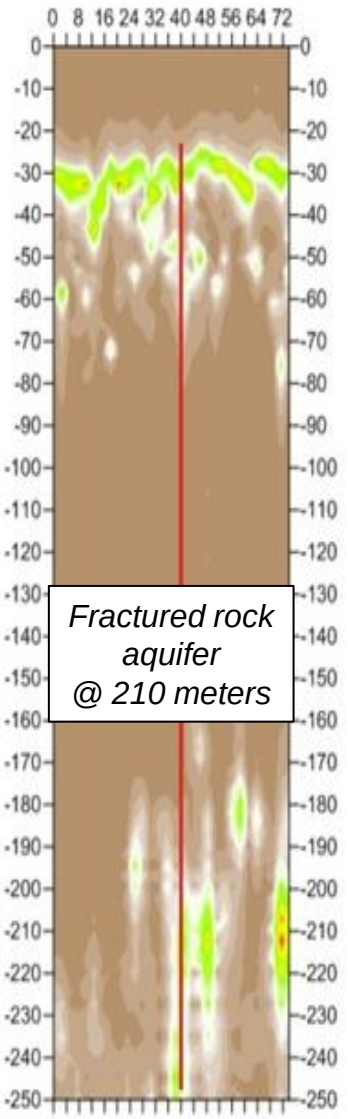
- Based on collecting background “noise”
  - Capable of low frequencies at depths exceeding 2000 meters
  - Allows profiling of geologic formations based on density/porosity of rock
  - Our focus is on near surface targets for “fissure water” and domes of rising primary water in fractured rock formations



Rapid 2-D and 3-D profiling

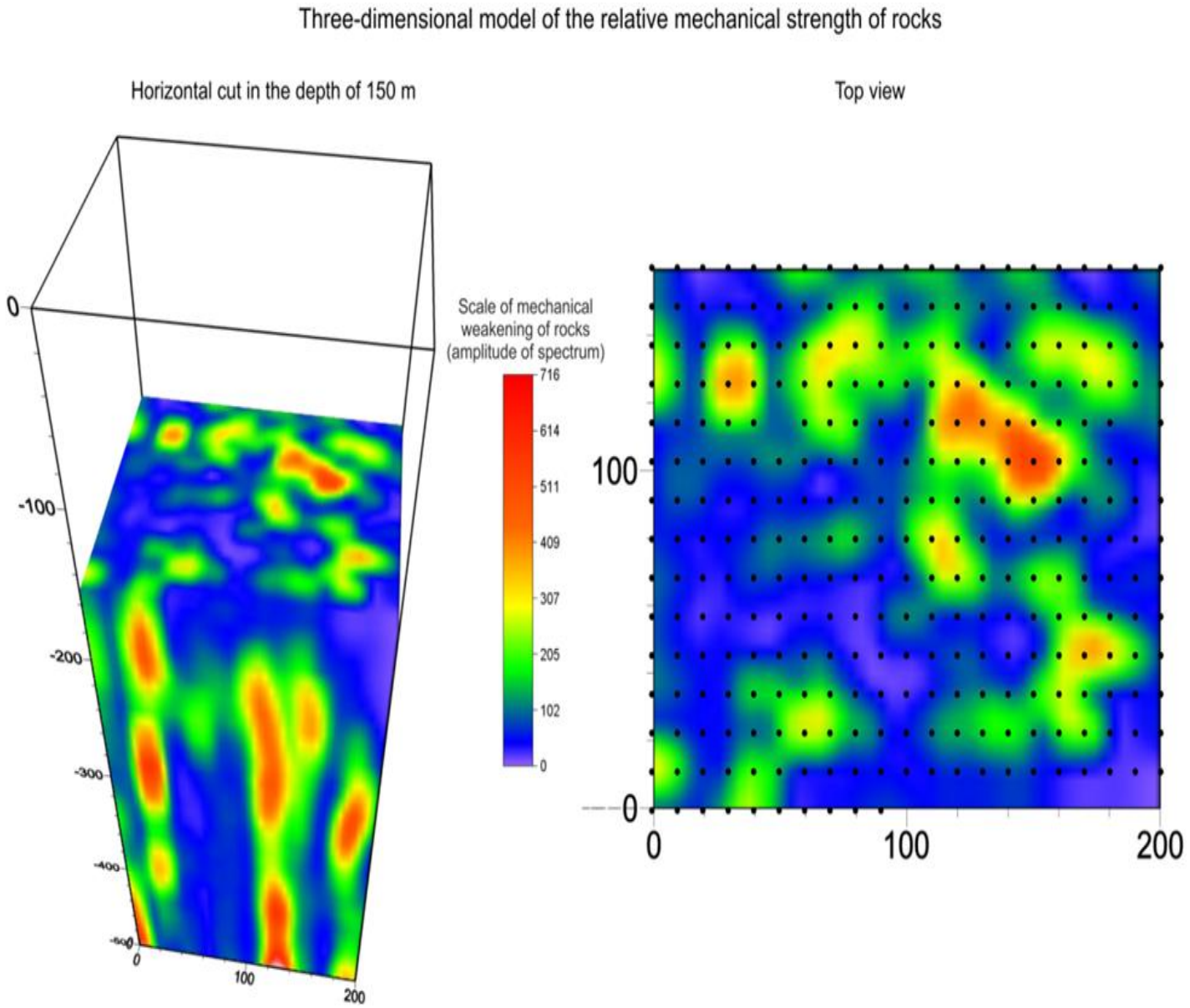






X-axis represents survey line, Y-axis the depth; both in meters

Rapid 2-D and 3-D profiling



Bio-indicators

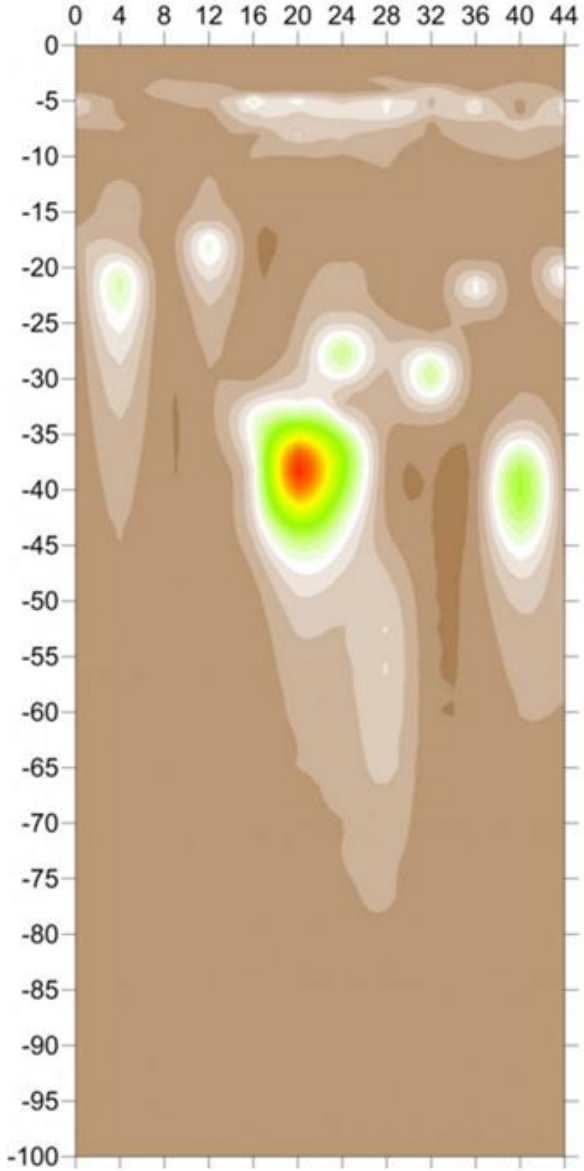
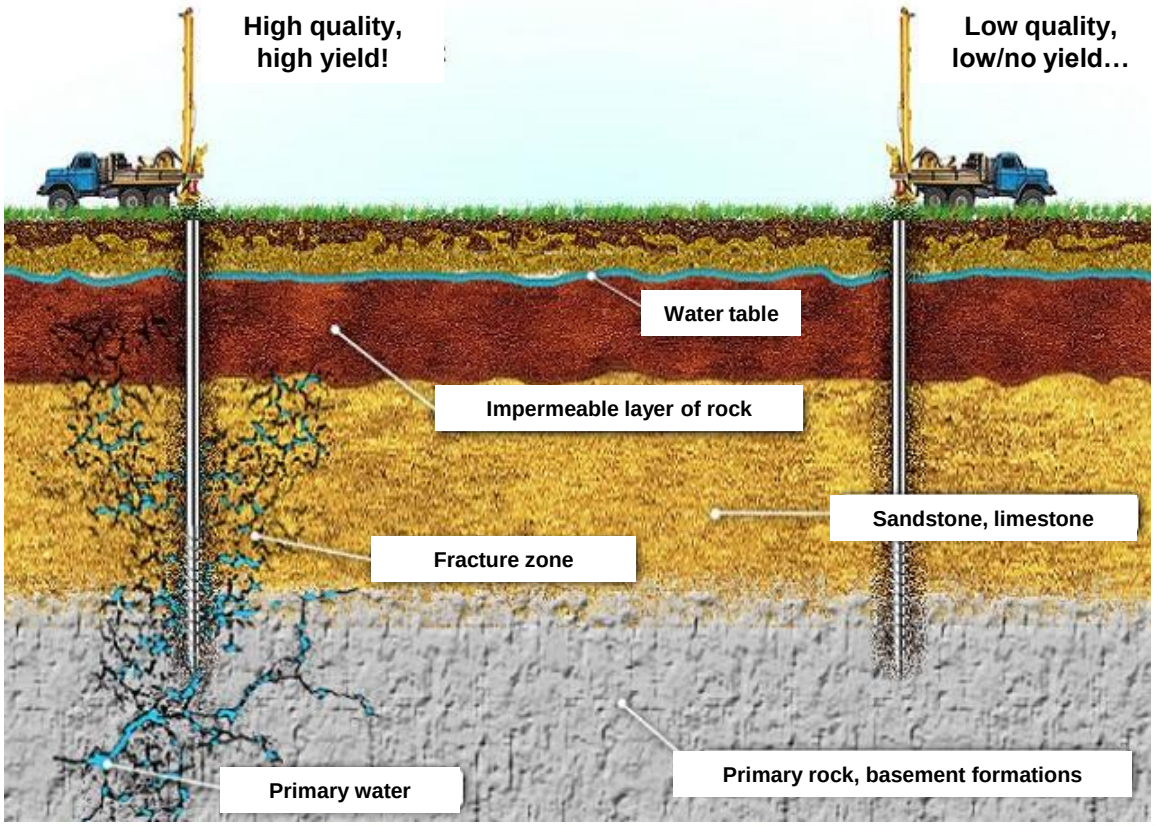


Illustration of how the plants suffer from growing along the tectonic disturbances.

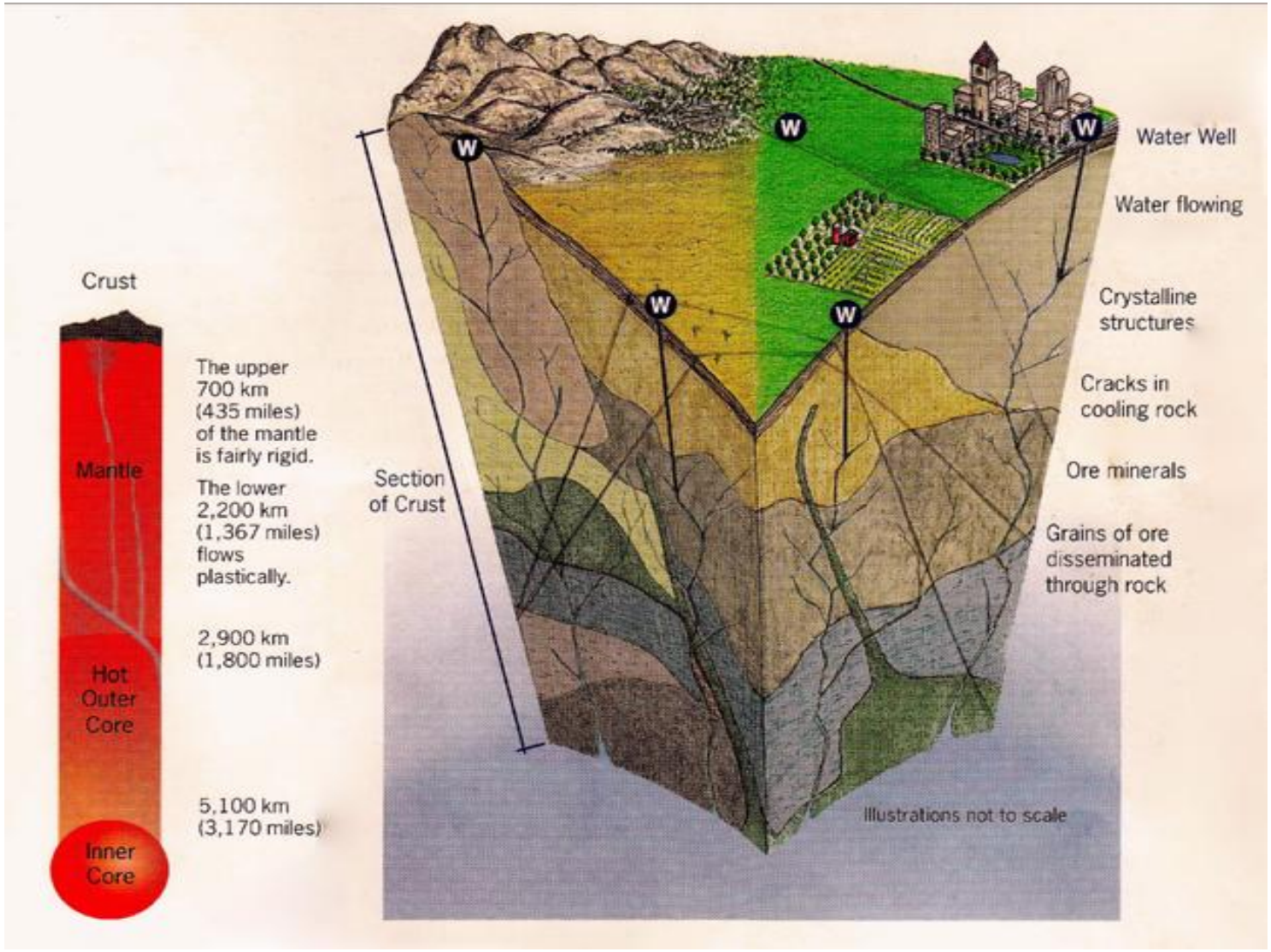
Ref: Geoliss - Russia

So how do we drill for it?

- Thousands of primary water wells have been drilled **worldwide**, many of them **open-bore** through bedrock. Traditional water well borehole drillers must learn to use **near-100% rotary air** and secondary air compressor (**min. 900 cfm**) **or preferably DUAL ROTARY**
- Operators can be taught "**precision drilling**" techniques



Locate and drill where needed



PW channel intercepted at 844’ / 253m

PW channel intercepted at 844’ / 253m

3 m^3 per minute x 60 = 180 m^3 per hour

180 m^3 per hour x 24 ≃ 4000 m^3 per day

4000 m^3 per day x 365 ≃ 1.5 million m^3 per year

San Diego County, California, USA

PW channel intercepted at 844’ / 253m

Continuously producing wells for more than 25 years

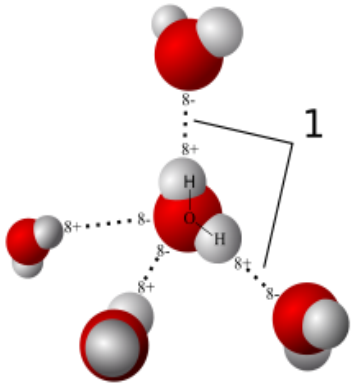
PW channel intercepted at 844’ / 253m

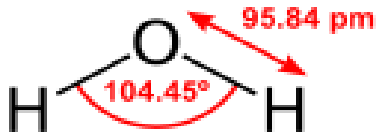
Methodology

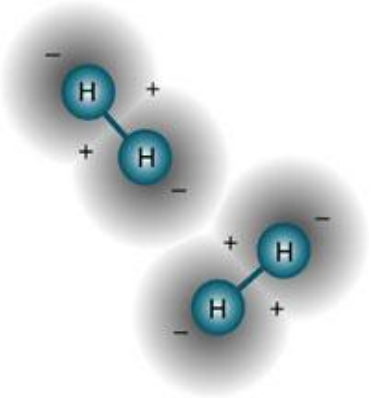
- “It can be seen that prospecting for primary water utilizes knowledge from geochemistry, petrology, mineralogy, crystallography, **physical chemistry**, as well as structural geology.”— Salzman (1960)
  - Tectonics/Seismics and Volcanism rupture the earth’s crust
  - Structural Geology identifies hydrothermal formations
  - Remote Sensing narrows candidate areas for drilling
  - Petrology, Mineralogy and Botany pinpoint the drill sites
  - Advanced geophysical surveys applied to locating water
- Primary water produced is pure, potable; no filter needed
- **Chemically distinct from hydrologic rain-cycle sources**

Primary Water Characteristics

- Primary Water will be distinct from traditional rain-fed water wells
  - Moving underground and thus self-cleansing naturally through rock
  - Often near surface in primary rock formations
  - Potable without filtration and minerally balanced
  - High negative charge is extremely healthy for humans, animals and plants



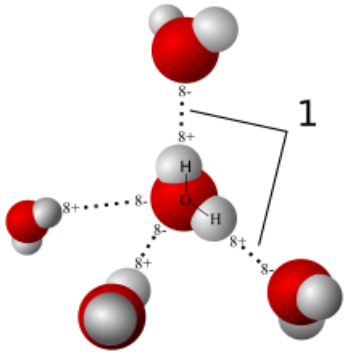




Ref: Dr. Gerald Pollack

Physical Chemistry

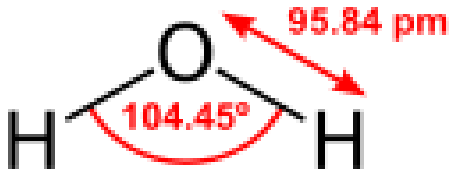
- Water is a simple compound of H_2O and it is the most abundant substance on Earth. Water is fundamental to life and exists in the atmosphere (as vapor) and deep into the Earth's mantle. Most living things comprise at least 70% water, and it readily bonds with other elements through its unique electric dipole in which the positive (+) and negative (-) charges are separated. The oxygen carries the negative charge and the hydrogen carries the positive charge. Hydrogen can bond with other electro-negative atoms, such as oxygen and nitrogen. This is why water has such a wide diversity of structures and possibilities in nature.



Ref: Dr. Gerald Pollack

Structured Water

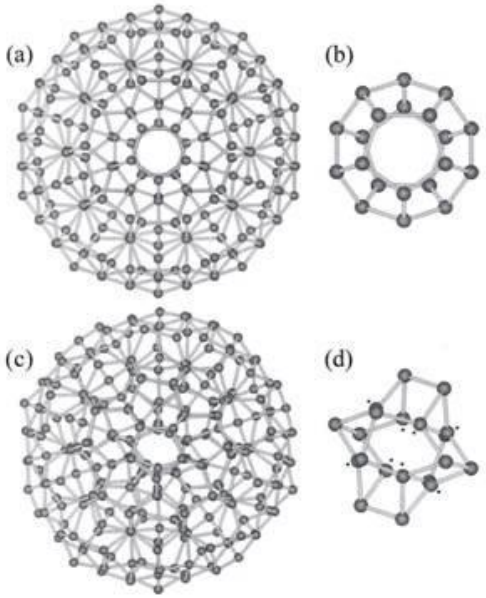
- While water is the most studied substance on Earth, it is remarkable that the science behind its behavior and function is so poorly understood. The small size of its molecule belies the complexity of its actions and its capabilities. Liquid water's unique properties and nature fit ideally into the requirements for life as no other molecule. **An important feature of the structure of water is its capability to change the angle of the hydrogen ion to the oxygen and the distance of the hydrogen ion to the oxygen ion.**



Ref: Dr. Gerald Pollack

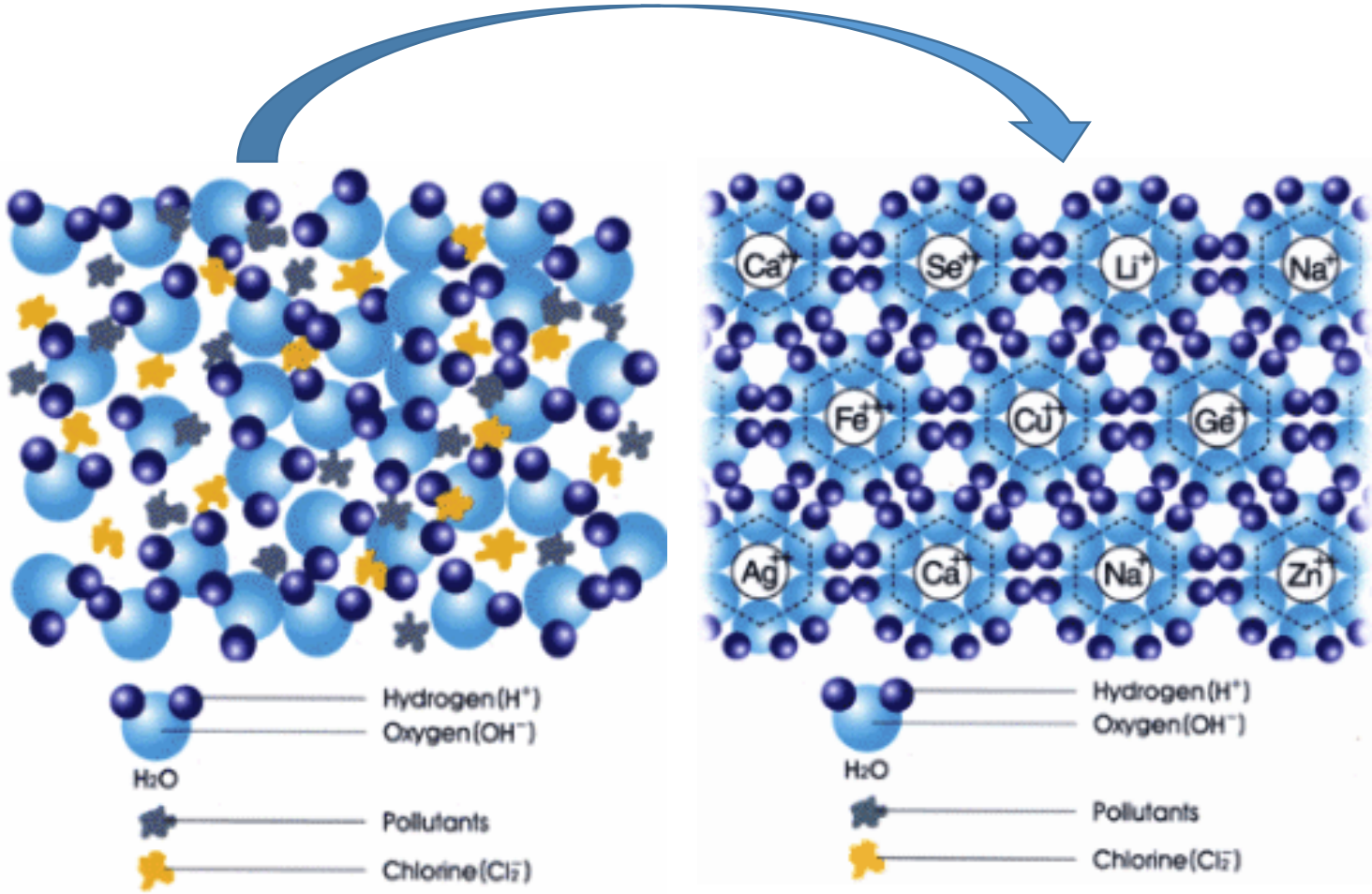
Structured Water, cont.

- Liquid water is best described as an intimate mixture of two liquid phases: one that has good three dimensional hydrogen bonding, an open and less dense structure and with lower hydration capability; and one that consists mostly of hydrogen-bonded chains, with a denser, more compact structure and greater hydration capability for all life forms.



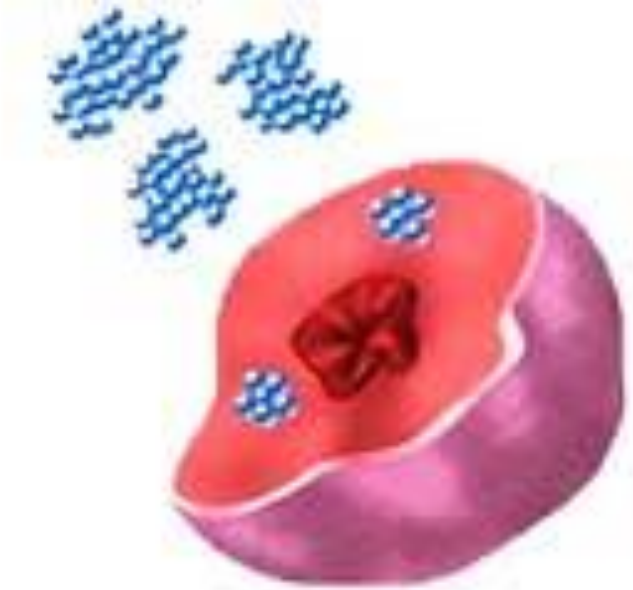
Ref: Dr. Gerald Pollack

Structured Water Exclusion



Ref: Dr. Gerald Pollack

Cell Penetration



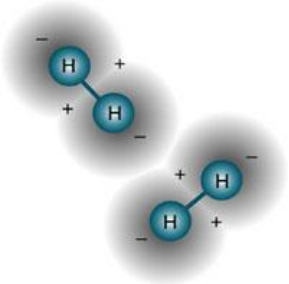
Large water clusters do not hydrate cells easily.

Small water clusters can easily penetrate cells for improved hydration.

Ref: Dr. Gerald Pollack

Negative Hydrogen Ions

- Research has also determined that the H- ions are potentially enhanced or concentrated in the water vortices and in the presence of biologically active water (i.e., water with a high diversity and abundance of beneficial microbes). This gives rise in natural systems to the concentration of H- in flowing water, biologically active ponds/ lakes, and soils.
- This little known nutrient (H-) is, in fact, the smallest element known to exist at this time, and existed before any life on Earth. In spite of its size, it is indispensable in virtually every chemical reaction in water, soil, plants, animals and humans. Nowhere is this more important than inside the cells where tiny organisms, called mitochondria, translate the free electron negative charge associated with the H- molecule into the ATP (adenosine-triphosphate, the source of chemical energy and a catalyst for inter-cell energy transfer) which provides the energy necessary to produce growth, repair and regeneration.



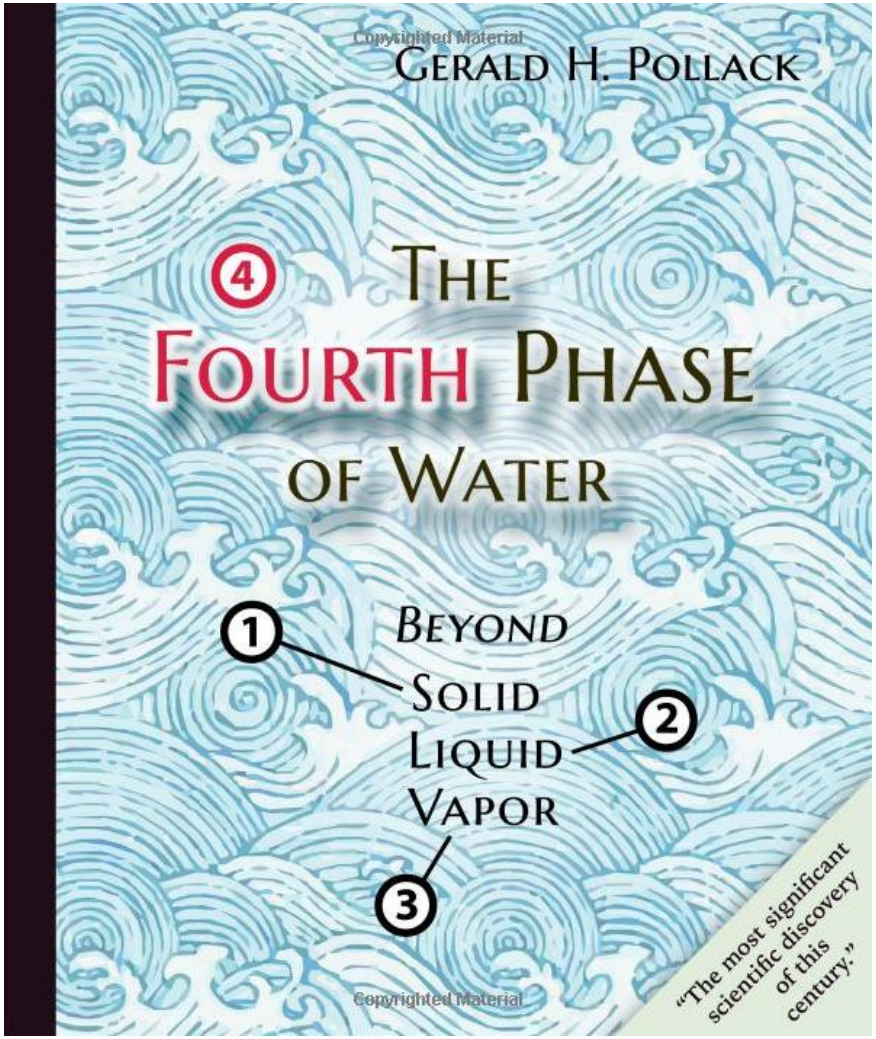
Ref: Dr. Gerald Pollack

Water Flow: Vortex

- The dynamics of water flow energy and vortex geometry are important factors in the design of water conditioning devices for a wide range of applications. Water flows or behaves in a predictable vortex pattern based on its molecular structure and environmental conditions, i.e. space dimensions in a river or pipe and effects of external energies such as magnetism and gravity. For example, water current charge and direction can be influenced by the magnitude of magnetic strength.
- The water vortex possesses extremely high and diverse levels of energy that can be utilized for an abundance of practical applications. The energy potential of vortices is possibly best exhibited by the most familiar kind of vortex, a tornado. The shear forces caused by the rapid air velocity at the vortexial apex of the tornado are evidence of the vast amounts of energy a vortex can generate. The same principle is true for vortices in a body of water. The energy of the vortices can be used for several applications by converting the mechanical energy of the vortices to other kinetic energy, such as electrical energy. That is, **moving water creates energy or charge**.

Ref: Robert Gourlay, ***Phi'on***

Required Reading on Water!



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PW White Paper

- Blue Ocean Sciences of Goleta CA understands how primary water is created in the earth and is writing a white paper to be followed by a peer reviewed study (once sufficient wells are identified and tested):
  - Analytical Methods – there are a variety of chemical signatures that can be used to identify PW:
    - 1) Colorimetric measurements for the mineral content of water, including sodium, potassium, magnesium, and calcium,
    - 2) Stable Isotopic Ratio Mass Spectroscopy (IRMS) of water to determine the delta-oxygen and delta-hydrogen isotopes within the water samples, and
    - 3) Liquid Chromatography Mass Spec-Mass Spectroscopy (LCMSMS) on water samples to determine the contamination levels of modern day organic chemicals.

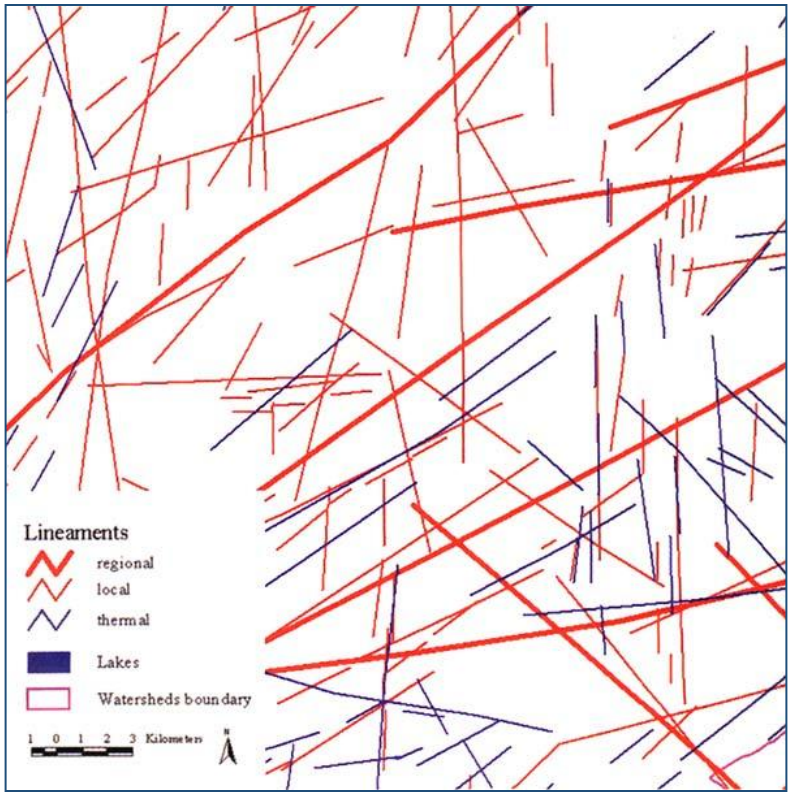
PW White Paper, cont'd

- The analytical results for mineral chemical footprint will indicate low levels of sodium ions versus potassium ions is an indication of a PW water source while the ratio of magnesium and calcium to the other minerals will be an indication of the mineral (rock) source.
- The IRMS analysis will have a shift in delta-oxygen ($^{18}O/^{16}O$) and hydrogen isotopes ($^{2}D/^{1}H$) ratios in PW that is not observed in other water sources. Tritium (^{3}H) will need to be verified to be not present in water older than 50 years.
- The presence of modern day organic contaminants, including pesticides, herbicides, pyrethoids, and phthalates in the water source is an indication of a contaminated aquifer source and not an ancient PW source.

A New Terminology is Emerging

Lineaments

(Fissures, Fractures, Faults…)



The Basement Connection

Joints, Linears, and Lineaments – The Basement Connection*

S. Parker Gay, Jr.[1]

Search and Discovery Article #41083 (2012)**
Posted November 30, 2012

*Adapted from oral presentation given at AAPG Rocky Mountain Section Meeting, Grand Junction, Colorado, 9-12 September 2012
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[1]Applied Geophysics, Inc., Salt Lake City, UT (spgagi@aol.com)

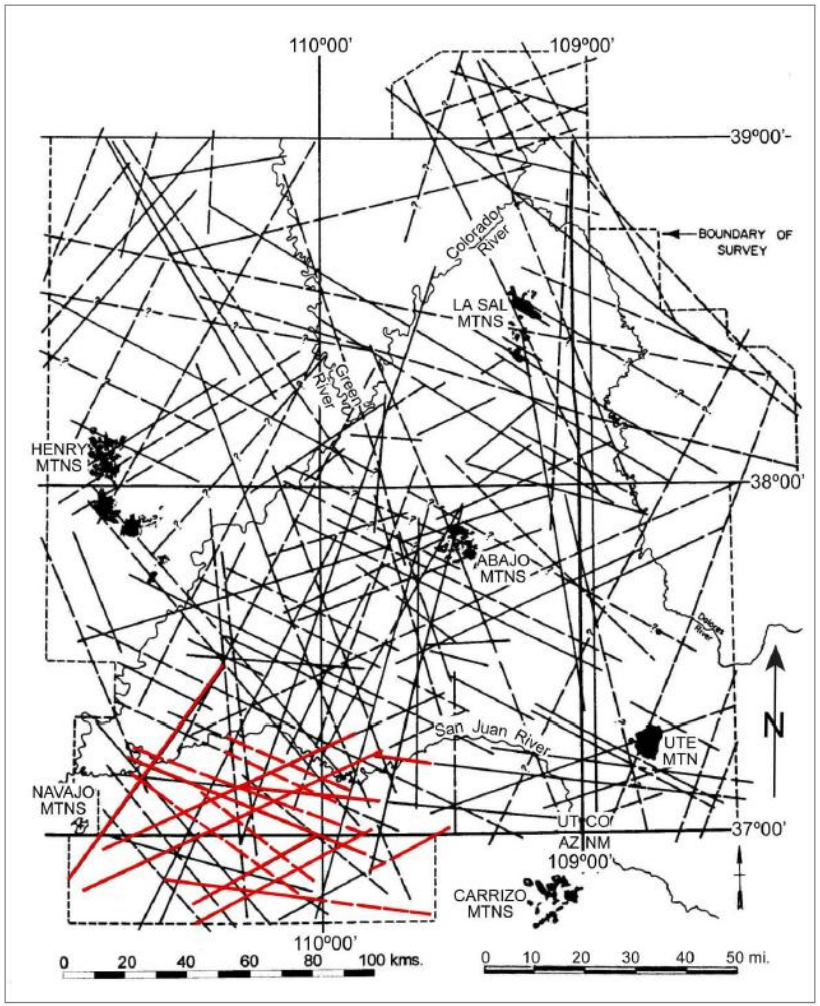
Abstract

Although some geologists understand the connection between basement faults and (1) joints, (2) linears, and (3) lineaments, many do not, and a few even disparage the idea of a connection, in spite of well-documented proofs dating back to the 1960's and 1970's. Briefly, small meter-scale movements of basement faults under recently lithified sedimentary rock create joints. These joints are parallel and cover large areas because the underlying basement faults (actually shear zones) fall into parallel sets that cover large areas. Most areas of earth's continental crust are underlain by three or more basement fault sets, thus resulting in three or more directions of jointing. Some joints also result from later stresses in the sedimentary section that create folding. These overprint the original basement-related joints. Basement-created joints are not evenly spaced, and where they are more numerous due to inhomogeneities in the sedimentary section and/or where groundwater is channeled along them, airphoto linears and Landsat lineaments result - features which are parallel to, but not necessarily coincident with, the underlying causative basement faults. Continued movement of some of the basement faults will result in fracturing and the formation of faults, folds, stratigraphic features, linears, and lineaments that are directly coincident with the underlying faults. Later migration of ore fluids, oil, and gas into these structures result in economic deposits important to man.

"I would like to redefine Bates and Jackson's **definition of a fracture** to be more in line with that used in the petroleum industry, i.e. **a planar break in a rock** intermediate between a joint and a fault that, if not re-cemented with silica, calcite or other minerals and not occluded by clays, is **capable of transmitting fluids, such as oil, gas, and water**."

Navajo

- Basic lineament studies exist… from 45 years ago!
- These show high level joints, faults, fractures, fissures
- Water resource mapping using advanced geophysical analytics will reveal more lineaments-- and which ones carry the signature of high probability for primary water.



Ghana Groundwater

Ground-Water Exploration Based on Lineament Analysis and Reproducibility Tests

by Per Sander[a], Timothy B. Minor[b], and Matthew M. Chesley[b]

(1997)

Abstract

Lineaments derived from remote sensing data are analyzed with respect to ground-water exploration in the Voltaian Basin of central Ghana. The lineament data were collected using both Landsat TM and SPOT imagery, multiple interpreters, and multiple trials. Three types of reproducibility tests are analyzed: (1) azimuth-length comparisons, disregarding location; (2) lineament coincidence using a raster-based comparison method; and (3) feature agreement using a rule-based approach. The reproducibility tests show that there are clear differences in length and location of individual line segments between interpreters, but that a large proportion of the inferred structural features are detected by all interpreters. Fifty percent of the features on both imagery types are detected by any two interpreters and 40 percent by all interpreters. Lineaments classed as more hydrologically significant show a reproducibility of up to 90 percent between interpreters and justify the use of classifiers in lineament mapping. The application of the feature agreement approach, including classification by hydrological significance, shows the greatest promise for targeting successful well sites.

Ghana Groundwater

Fig. 2. The lineament study area, with lineaments (SPOT and Landsat TM) and circles with 1 km radius from the 16 village centers. The lineaments originate from the first mapping by a single interpreter.

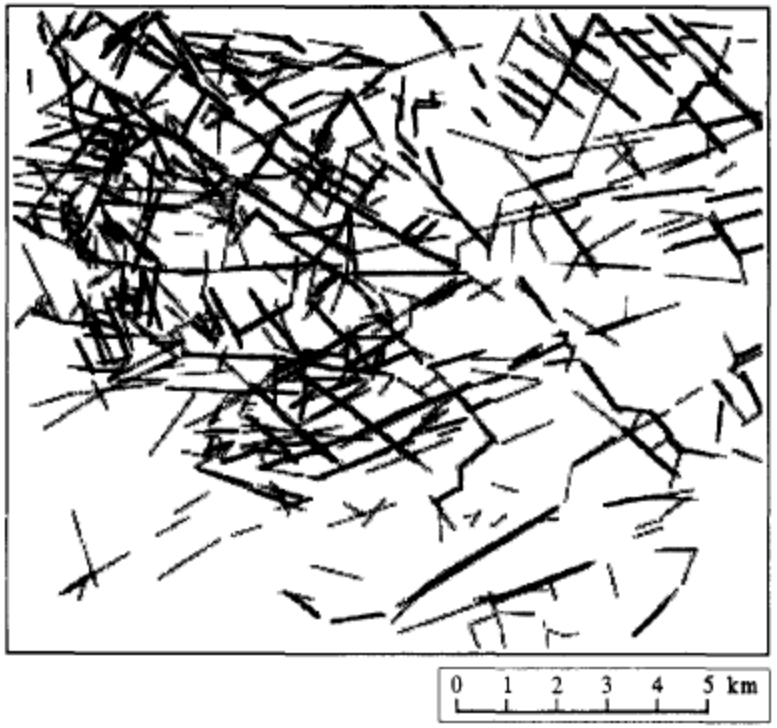


Fig. 5. The lineament study area showing different levels of agreement between interpreters from the raster-based method. The agreement is shown as intensity levels from poor agreement (white) to good agreement (black).

Ghana Groundwater

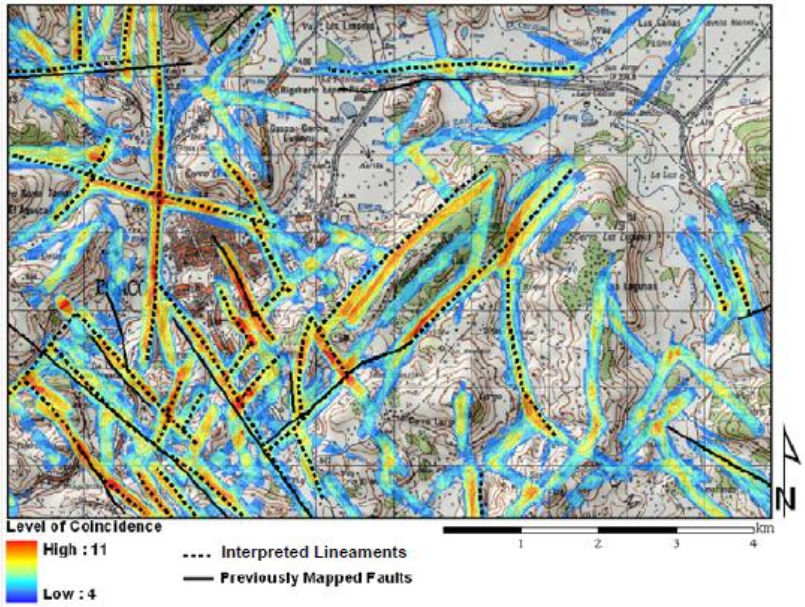
Application of Reproducibility Tests in Well Siting

The ultimate goal of identifying promising linear features from remote sensing data, in a project like the GRWP, is to increase the success rate of well drilling. The previous well siting in the study area, without the aid of remote sensing data, left every second well dry, which initiated the development of better siting methods. A comparison with the existing wells in the lineament study area, shows that most of the dry or low yielding wells are located far from promising features, identified through the feature agreement approach, despite potential targets being available within one kilometer of the village centers. Some high yielding wells are, however, located in areas where very few lineaments have been detected. This may be due to dense and evenly distributed vegetation obscuring linear features in the vicinity of villages.

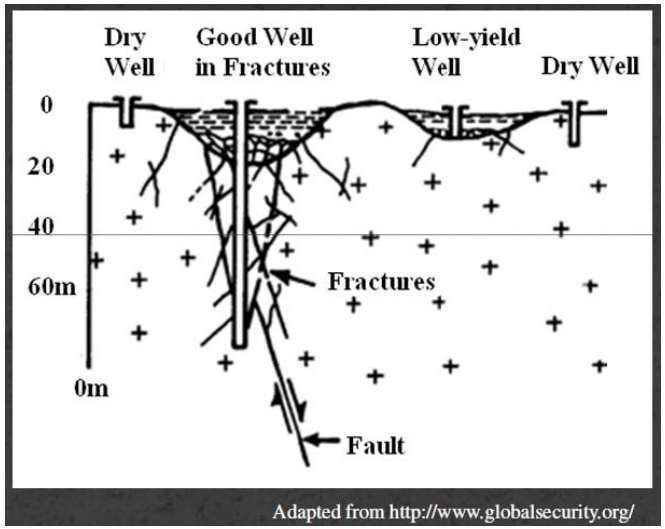
The success rate of well drilling (wells yielding more than 10 l/min) and proximity to features identified through the feature agreement reproducibility tests were compared. The results show that wells within 250 m of an identified feature show a success rate of 57% (23 wells) and wells located further away show a success rate of 41% (17 wells). However, of the wells within 250 m, the wells located closest to the identified features also show the lowest success rate, possibly related to the presence of clay gouge in some of the most distinct linear features.

Nicaragua Lineament Study

- "A Digital Processing & Data Compilation Approach for Using Remotely Sensed Imagery to Identify Geological Lineaments In Hard-rock Terrains: An Application For Groundwater Exploration In Nicaragua (**2008**)"
  - Jill N. Bruning, M.S. Geological Engineering thesis paper; John S. Gierke, Advisor
  - Using ASTER, Landsat7 ETM+, QuickBird, and RADARSAT-1



Fiugre 6. Coincidence Raster and Final Lineament Interpretation.



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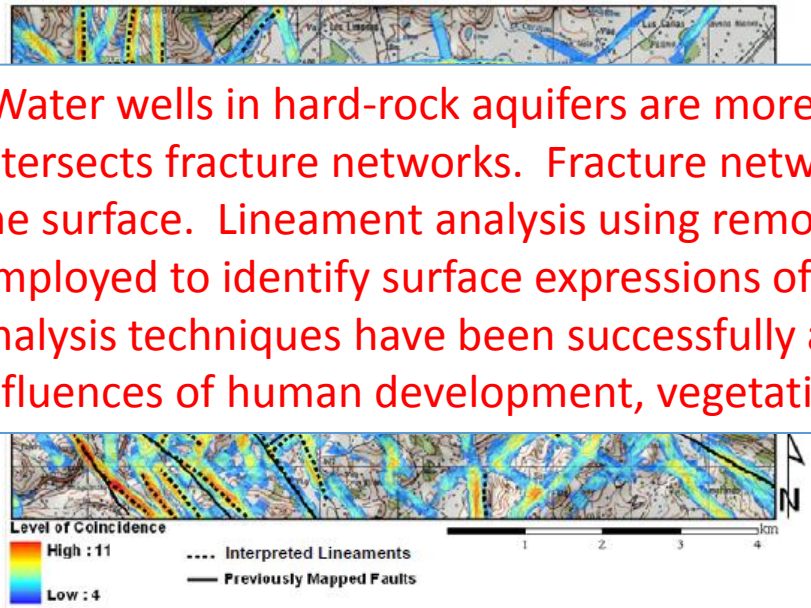
  - Using ASTER, Landsat7 ETM+, QuickBird, and RADARSAT-1

"Water wells in hard-rock aquifers are more productive where the well bore intersects fracture networks. Fracture networks are often not readily discernable on the surface. Lineament analysis using remotely sensed satellite imagery has been employed to identify surface expressions of fracturing, and a variety of image-analysis techniques have been successfully applied in 'ideal' settings where influences of human development, vegetation, and climatic situations are minimal."



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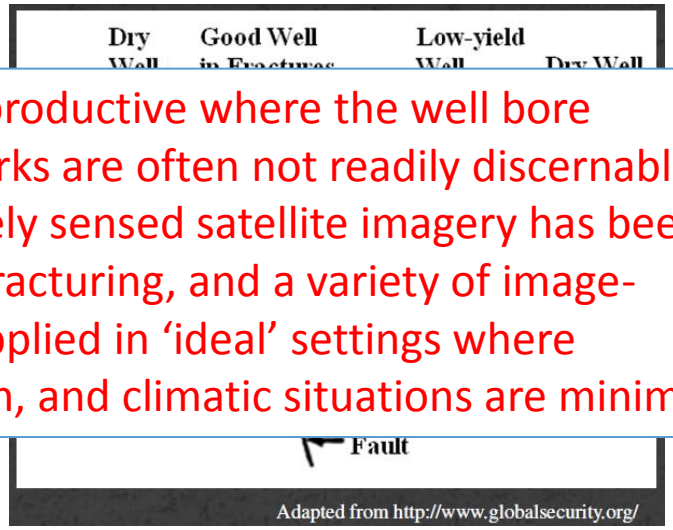


Puerto Rico Lineament Study

- "Lineament Mapping for Groundwater Exploration Using Remotely Sensed Imagery in Karst Terrains (**2011**)"
  - Carla Alonso Contés, M.S. Geological Engineering thesis paper; John S. Gierke advisor
  - Using ASTER, Landsat ETM+, Lidar (2 m) DEM

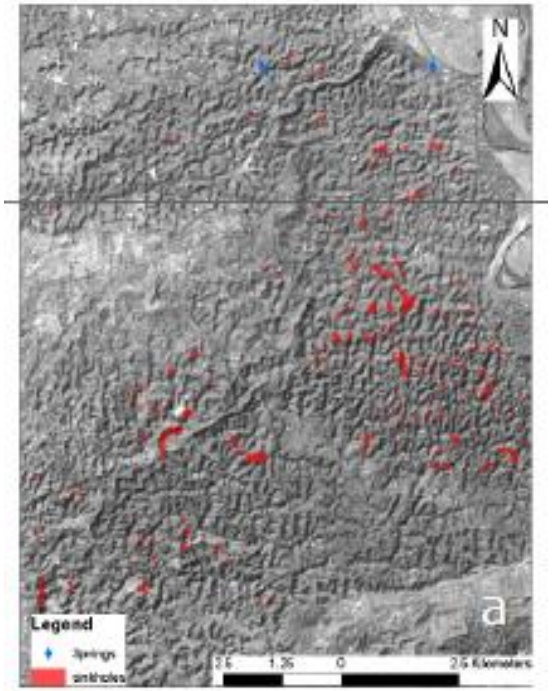
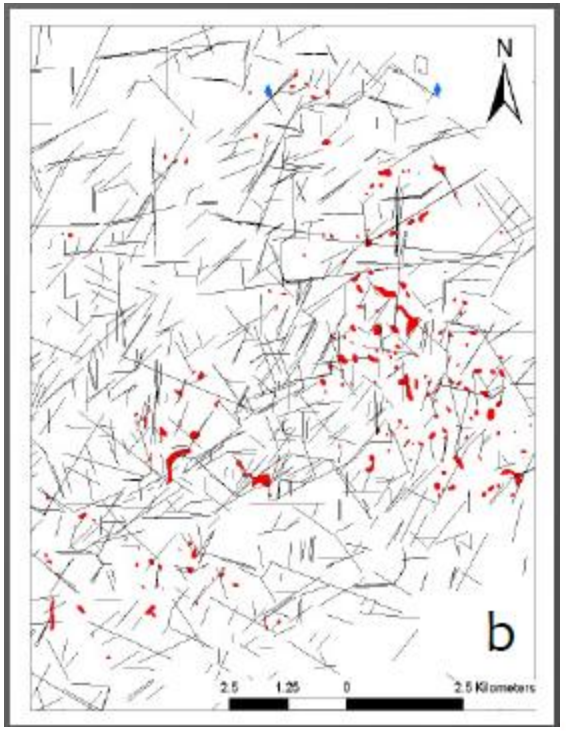


Figure 13:

a) Landsat ETM+ Band 8 with spring and sinkholes greater than 30 m deep locations (from Aleman, 2010)

b) Preliminary lineament



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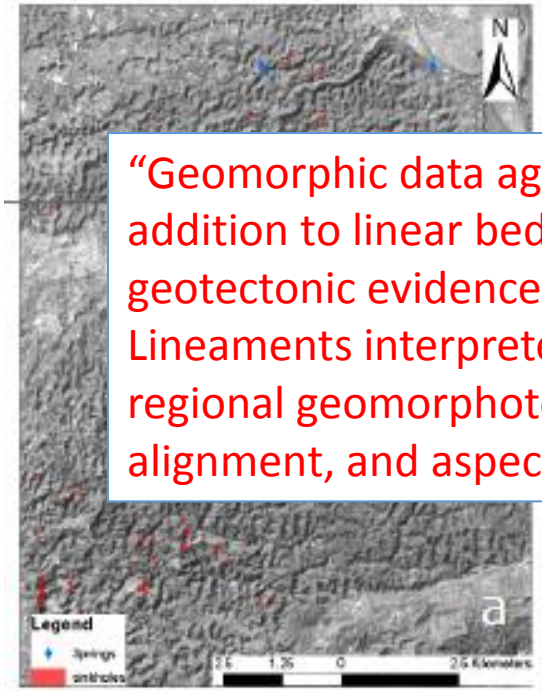
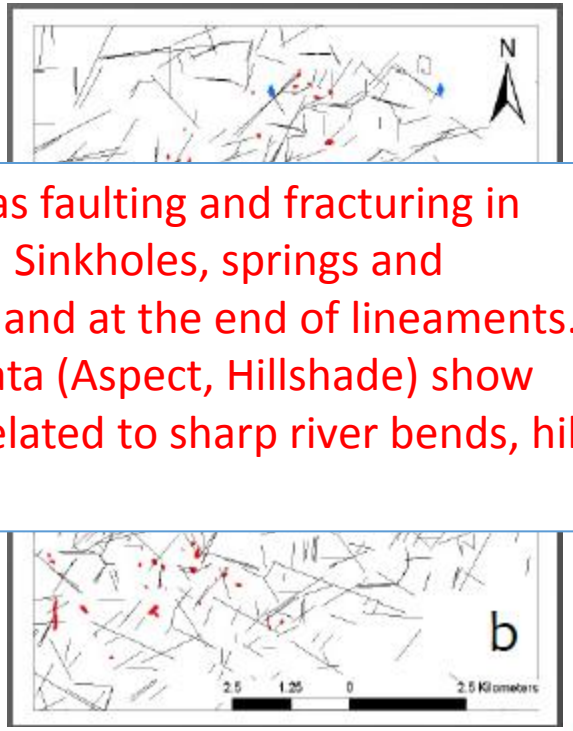
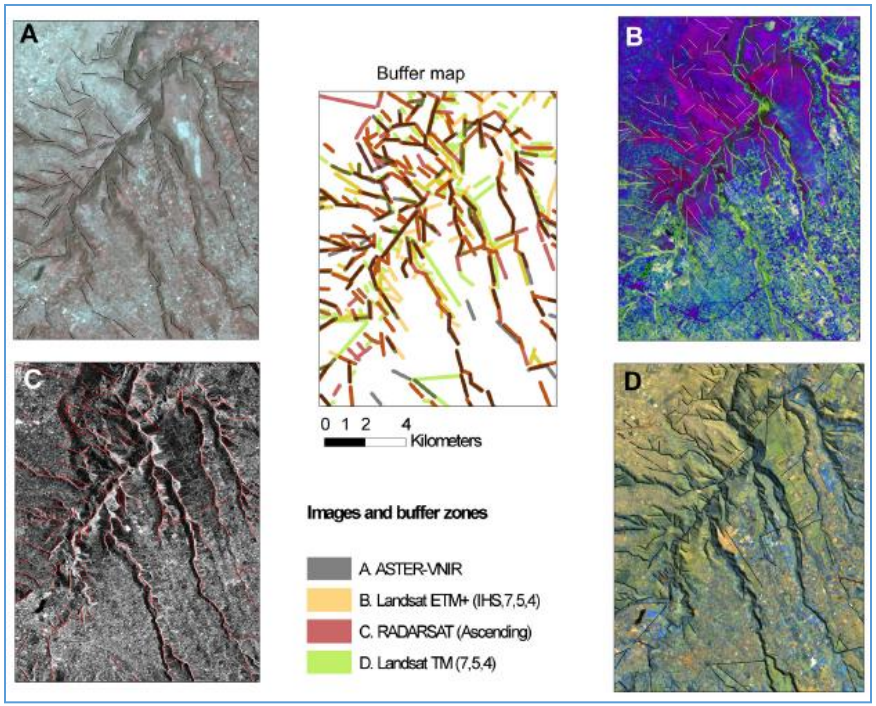


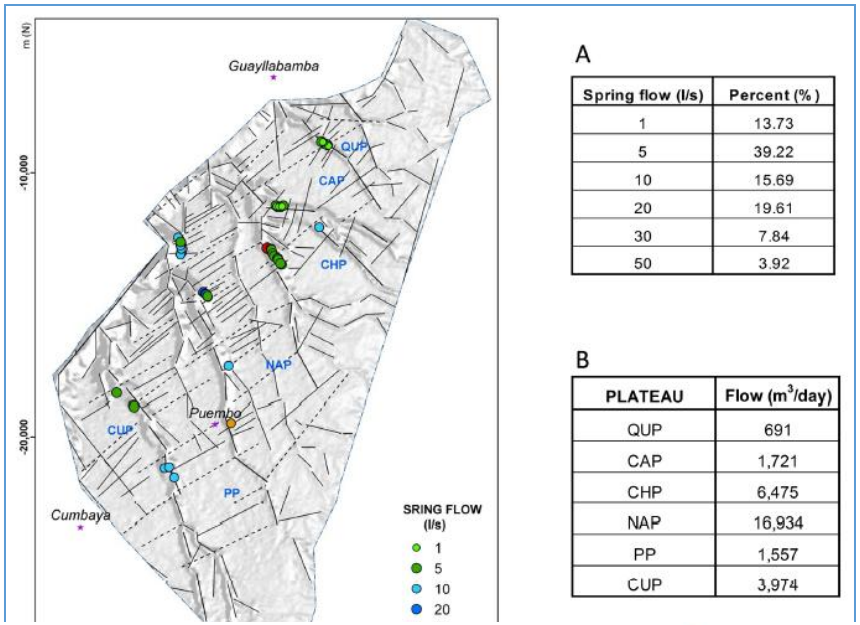


"Geomorphic data agrees with lineaments as faulting and fracturing in addition to linear bedding control features. Sinkholes, springs and geotectonic evidence locations occur along and at the end of lineaments. Lineaments interpreted from LiDAR DEM data (Aspect, Hillshade) show regional geomorphotectonic evidence correlated to sharp river bends, hill alignment, and aspect trends."

Ecuador Lineament Study

- "A Remote Sensing Approach to Characterize the Hydrogeology of Mountainous Areas: Application to the Quito Aquifer System… (**2012**)"
  - Miriam Rios-Sanchez, PhD Geological Engineering dissertation; John S. Gierke, Advisor
  - Using Landsat TM, Landsat ETM+, ASTER, RADARSAT, DEM





A

Spring flow (l/s)	Percent (%)
1	13.73
5	39.22
10	15.69
20	19.61
30	7.84
50	3.92

B

PLATEAU	Flow (m^3/day)
QUP	691
CAP	1,721
CHP	6,475
NAP	16,934
PP	1,557
CUP	3,974

Ecuador Lineament Study

- "A Remote Sensing Approach to Characterize the Hydrogeology of Mountainous Areas: Application to the Quito Aquifer System… (**2012**)"
  - Miriam Rios-Sanchez, PhD Geological Engineering dissertation; John S. Gierke, Advisor
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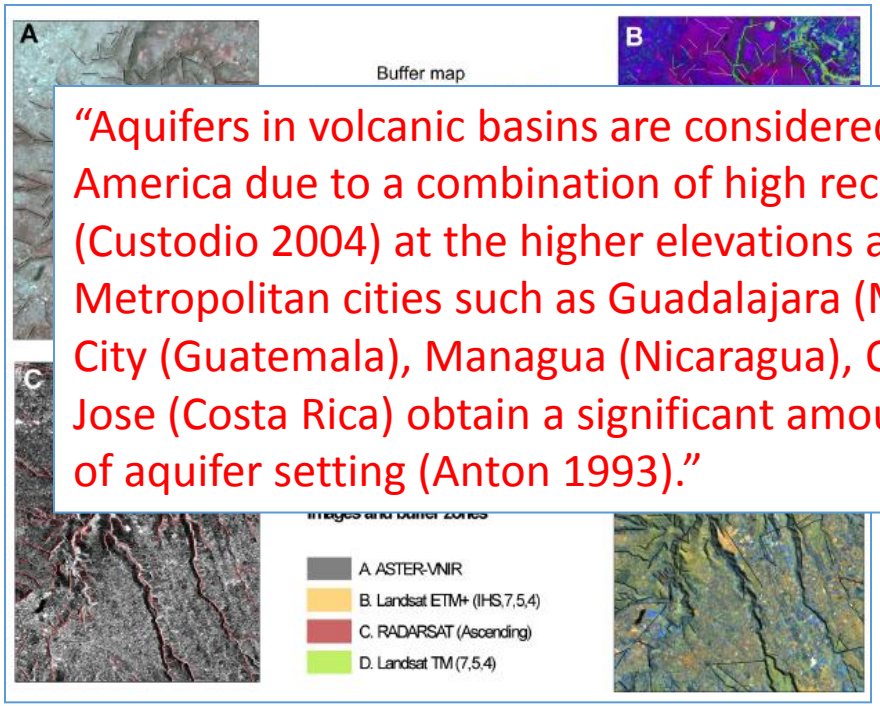
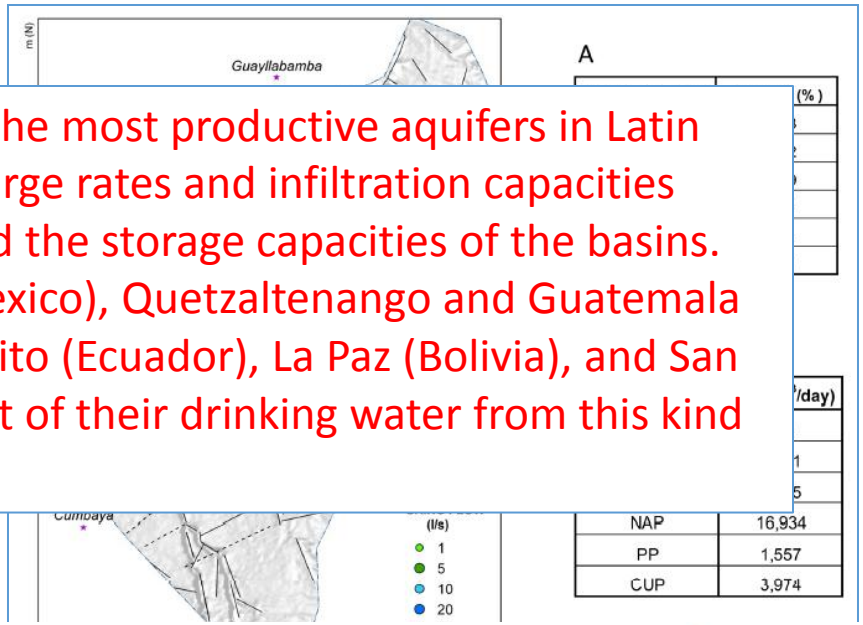
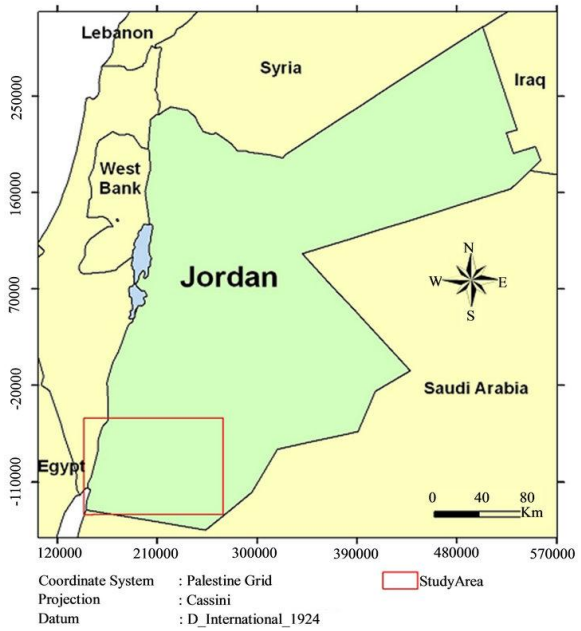


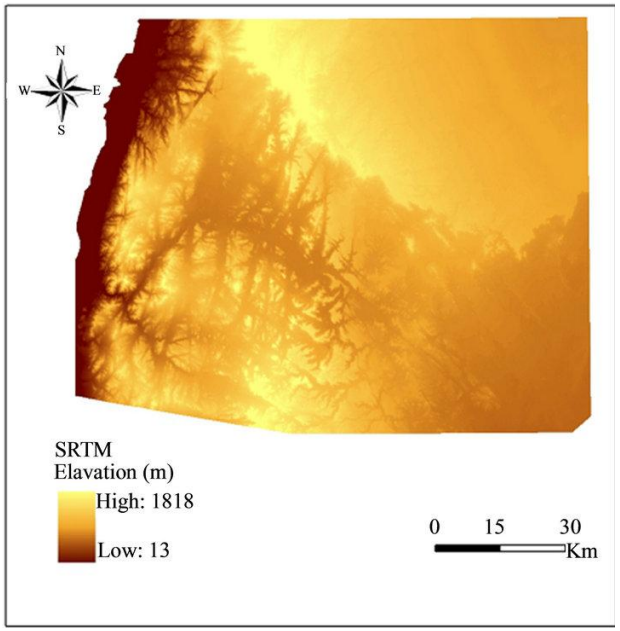


"Aquifers in volcanic basins are considered the most productive aquifers in Latin America due to a combination of high recharge rates and infiltration capacities (Custodio 2004) at the higher elevations and the storage capacities of the basins. Metropolitan cities such as Guadalajara (Mexico), Quetzaltenango and Guatemala City (Guatemala), Managua (Nicaragua), Quito (Ecuador), La Paz (Bolivia), and San Jose (Costa Rica) obtain a significant amount of their drinking water from this kind of aquifer setting (Anton 1993)."

Jordan Lineament Study

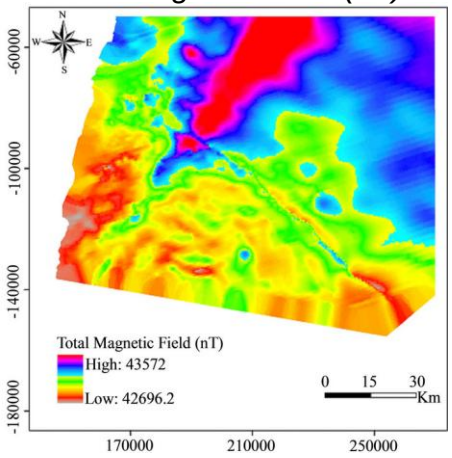
- "Integration of Aeromagnetic Data and Landsat Imagery for Structural Analysis Purposes: A Case Study in the Southern Part of Jordan (**2013**)"
  - Hani Al Amoush, Nezar Hammouri, Mohammed Al Farajat, Elias Salameh, Abdullah Diabat, Mohammed Hassoneh, Rida Al-Adamat
  - Airborne Magnetics and Landsat ETM+



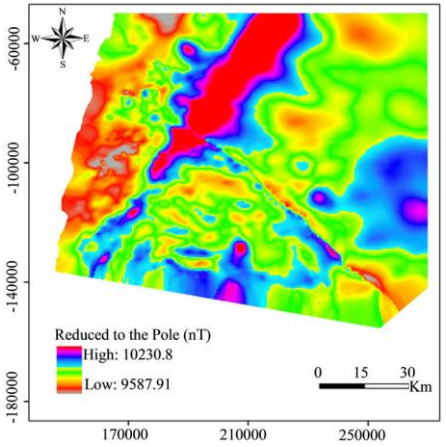


Jordan Lineament Study

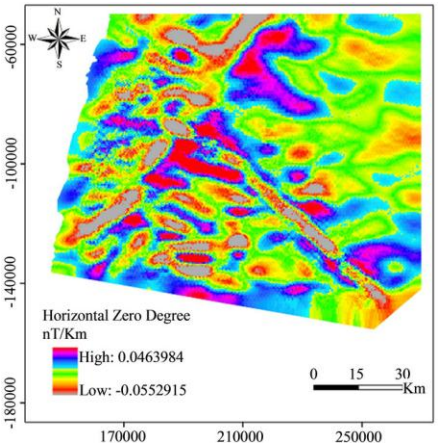
Total Magnetic Field (nT)



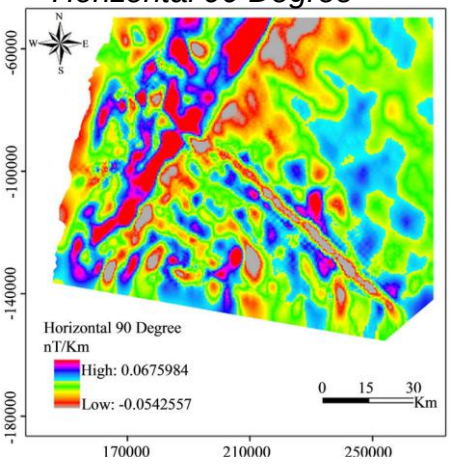
Reduced to the Magnetic Pole



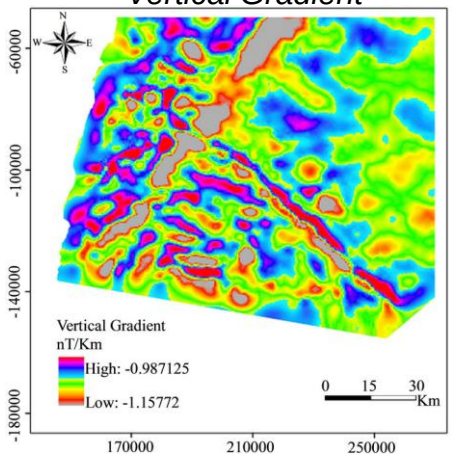
Horizontal Zero Degree



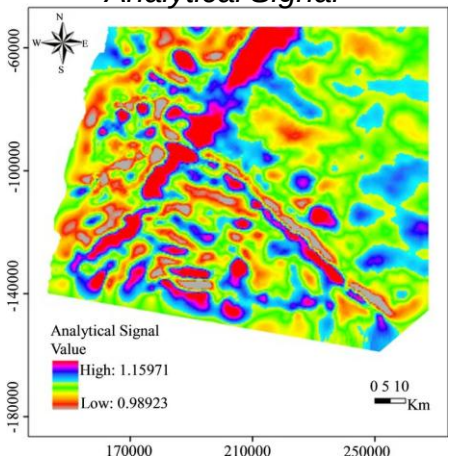
Horizontal 90 Degree



Vertical Gradient

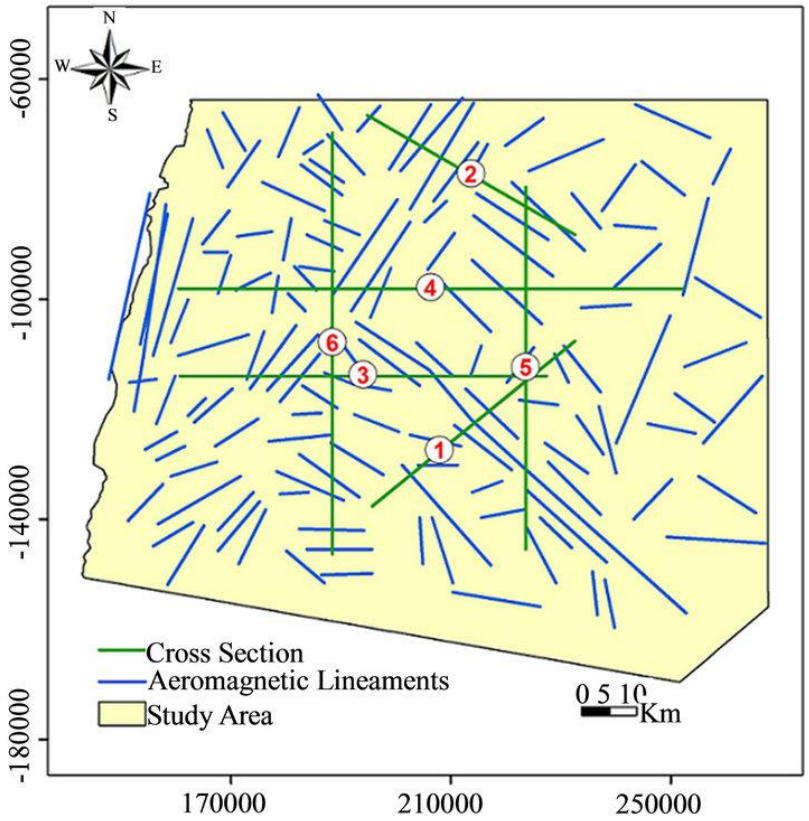


Analytical Signal

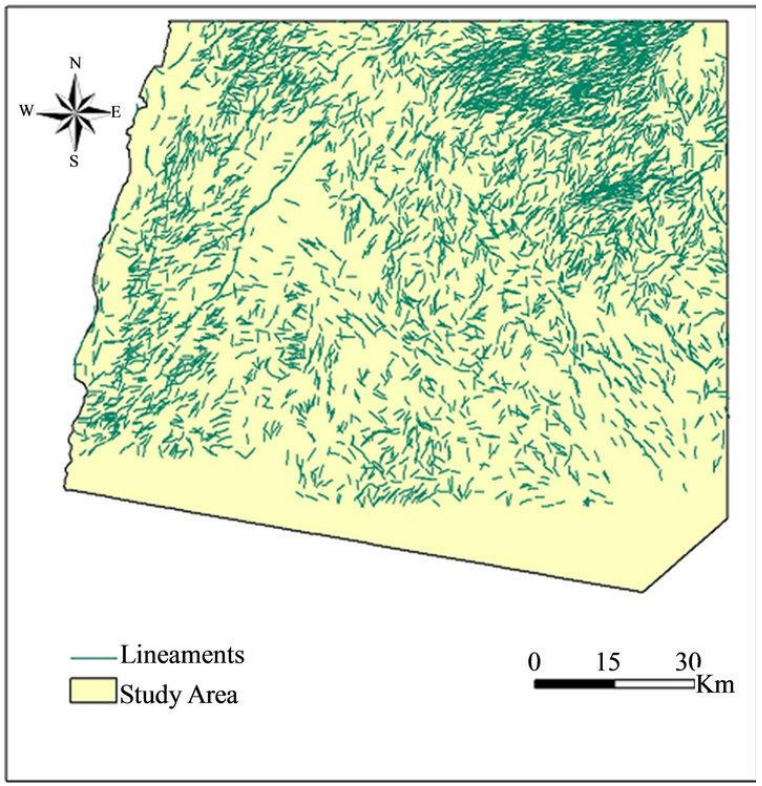


Jordan Lineament Study

"Aeromagnetic lineaments map and location of cross section profiles."



"Extracted lineaments using LINE module."



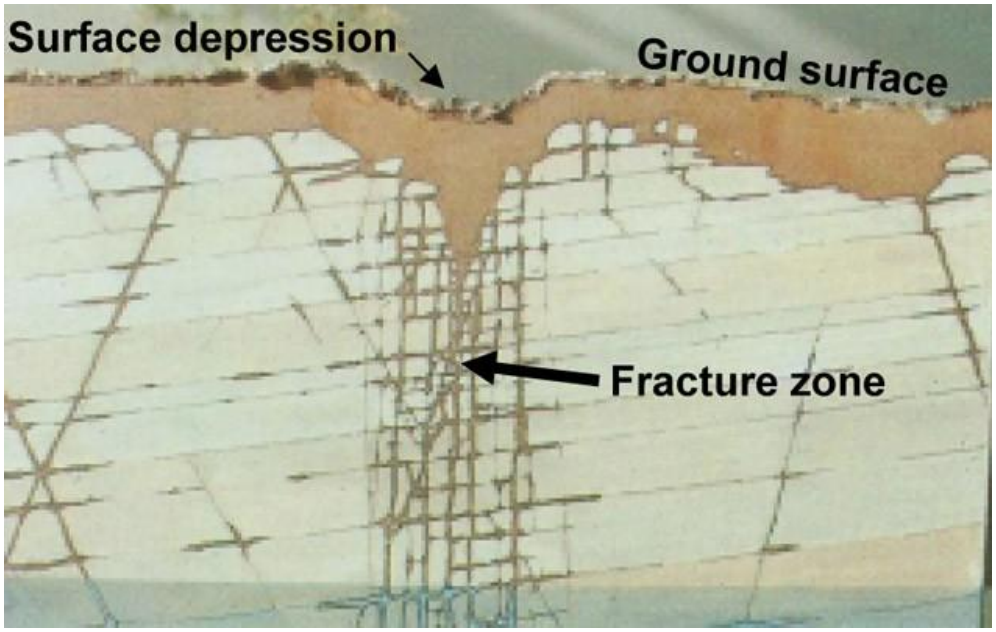
Jordan: al-Disi Aquifer

- The Disi Water Conveyance Project is a water supply project in Jordan. It is designed to pump 100,000,000 cubic metres of water per year (approx. 70M gpd) from the Disi aquifer, which lies beneath the desert in southern Jordan and northwestern Saudi Arabia. The water is piped 320 km (200 miles) to the capital, Amman, and other cities to meet increased demand. Construction began in 2009 and was mostly completed in July 2013. Its total cost was USD 1.1 billion under a BOT contract (GE/USA and GAMA Energy/Turkey) under 25-year concession.
- The tariff was agreed at (c. US$1.05) per cubic meter delivered
- **As of 2017 they are producing 90,000,000 cubic meters annually and have been asked to increase to 150,000,000 m^3**
- **Observations wells show <u>recharge</u> at depths of 600+ meters--below impermeable rock layers--of c. 50,000,000 m^3 annually!**

Fracture Trace Mapping

- The basis for fracture trace water well location is quite simple. There are zones of structural weakness in the earth's crust that contain zones of fracture concentration in the underlying bedrock. These fractures are actually cracks in the rock clustered in zones 5 to 50 feet wide, 100 to 200 feet deep, and several thousand feet to more than a mile in length. Each fracture zone may contain one or as many as 200 separate fractures or cracks **and there may be five or ten fractures or zones of fractures in any 100-acre area**.

http://extension.psu.edu/natural-resources/water/drinking-water/wells/water-well-location-by-fracture-trace-mapping



Fracture Trace Mapping

- In tightly cemented rocks, random drilling often fails to produce enough water to supply the needs of even an individual home. Any water use requiring water yields in excess of average yields for a particular area (Table 1) will in most cases substantially reduce groundwater development costs by applying this technique.

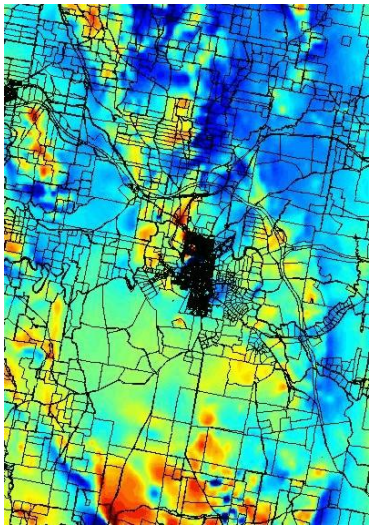
http://extension.psu.edu/natural-resources/water/drinking-water/wells/water-well-location-by-fracture-trace-mapping

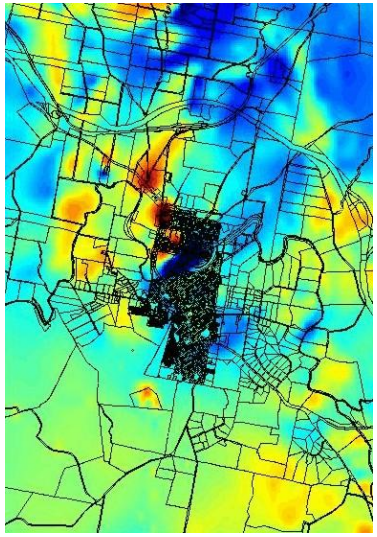
Rock Type	Avg. Yield (gpm)	Yield from Fractures (gpm)
Crystalline (marble etc.)	1-20	200-500
Sandstone, Shale	5-60	100-500
Carbonate (limestone, etc.)	5-500	500-3000
Unconsolidated (gravel, sand)	100-1000	Not Applicable

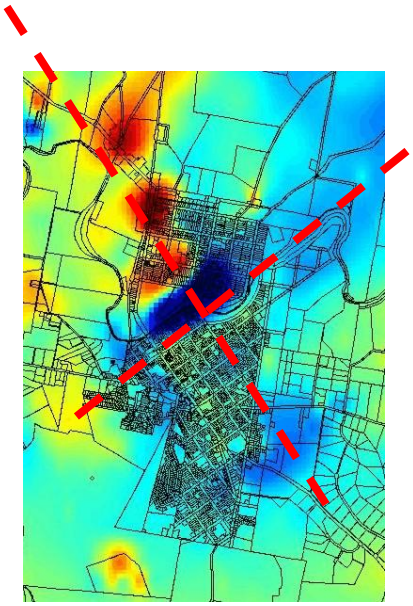
Table 1. The water yield in gallons per minute (gpm) from typical and fracture-trace wells in various geologic formations common to Pennsylvania, USA.

Our Commitment

- We will demonstrate how to classify “lineaments” using the full range of geophysical data and remote sensing imagery to locate high quality water resources worldwide **regardless of geology, soil or microclimate.**
- Example of Yass NSW, Australia:







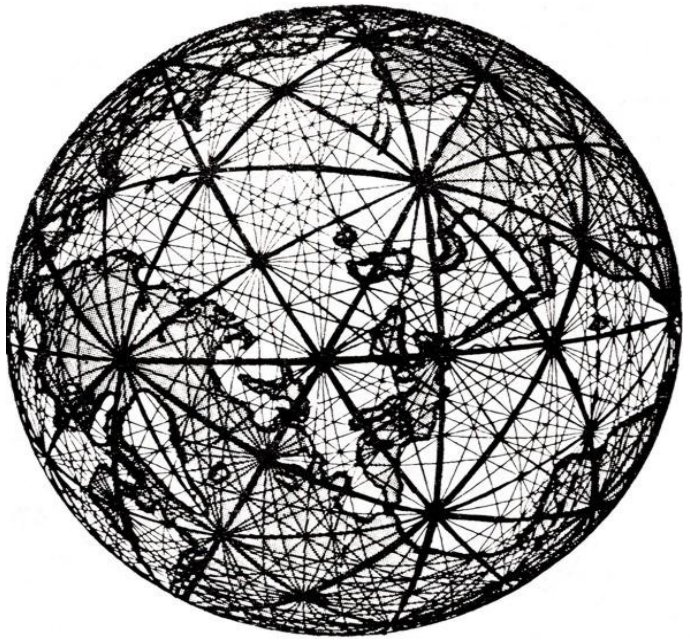
High quality water source discovered… beneath the city!

Mapping the grid for exploration

- The ancients…and not so ancients…understood this!

Ref.: Georgius Agricola "*De Re Metallica*" 1556

Mapping the ***World Grid,*** was popular in the Middle Ages and many techniques are still used by the dowsers of today.



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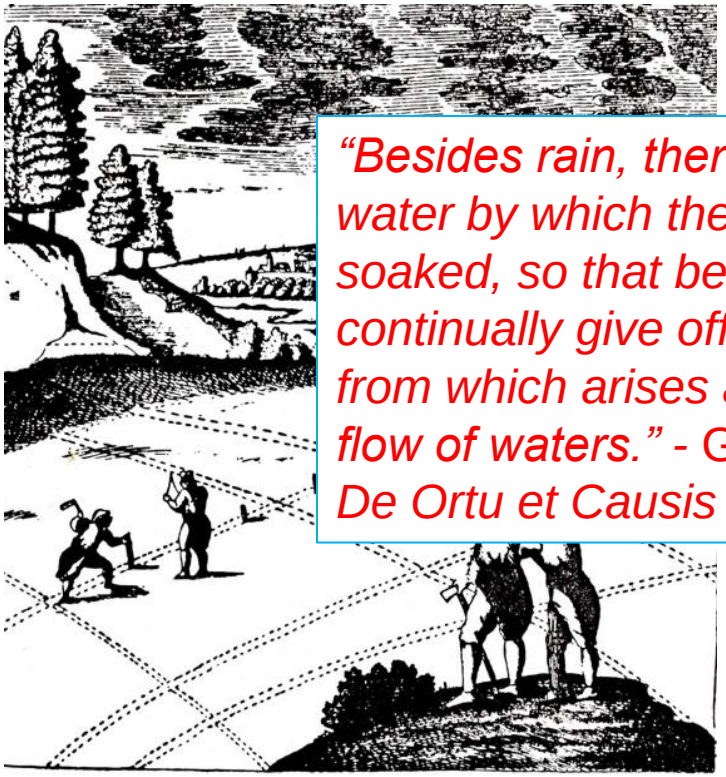

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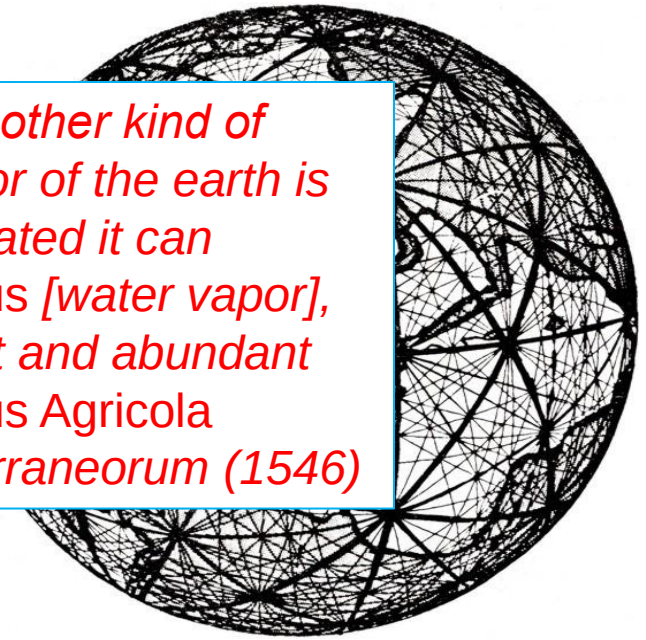
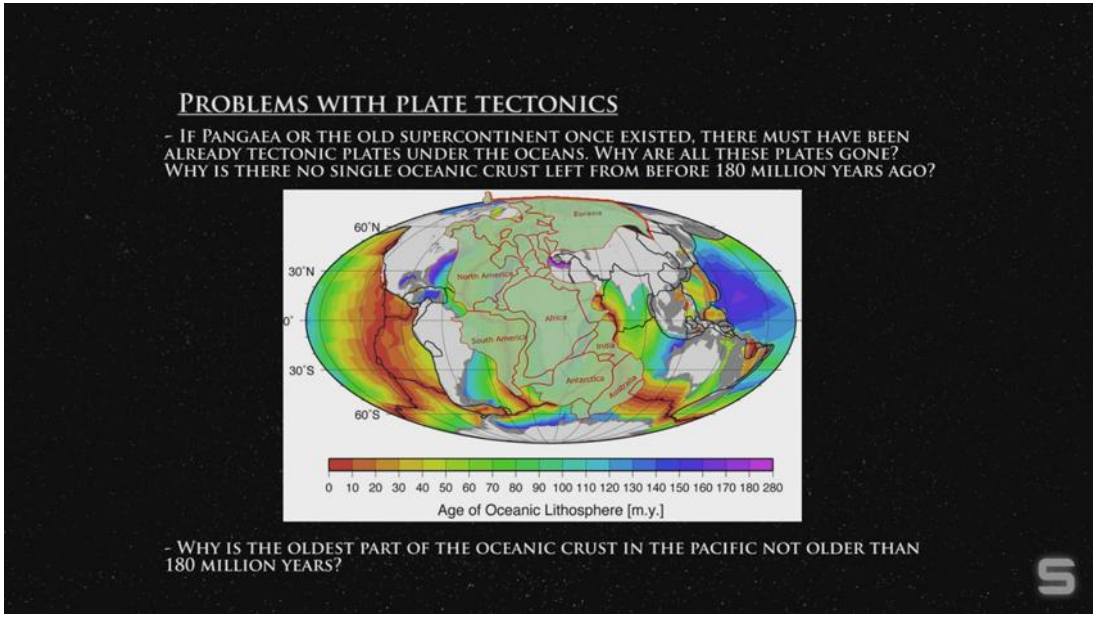


"Besides rain, there is another kind of water by which the interior of the earth is soaked, so that being heated it can continually give off halitus *[water vapor], from which arises a great and abundant flow of waters."* - Georgius Agricola
De Ortu et Causis Subterraneorum (1546)

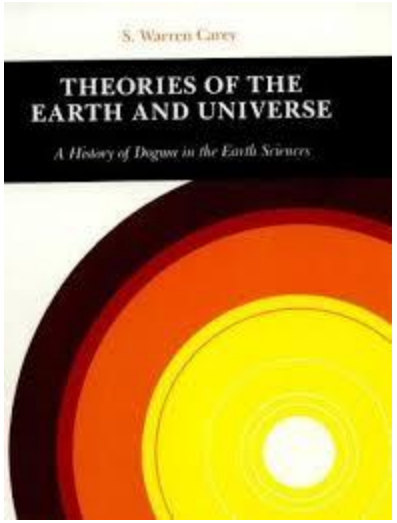
Expansion Tectonics

- Critical to understanding why fractures form



https://www.youtube.com/watch?v=tiCMFzpMnZM

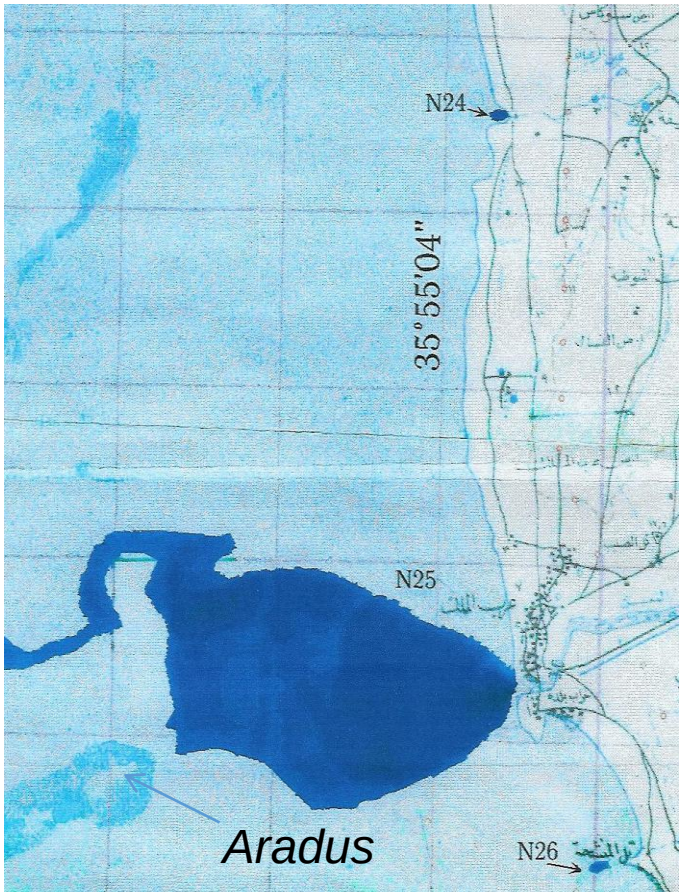
Samuel Warren Carey
Theories of the Earth and Universe:
A History of Dogma in the Earth Sciences
1988 - Stanford University Press



https://www.youtube.com/watch?v=oJfBSc6e7QQ

Upwellings: Syria

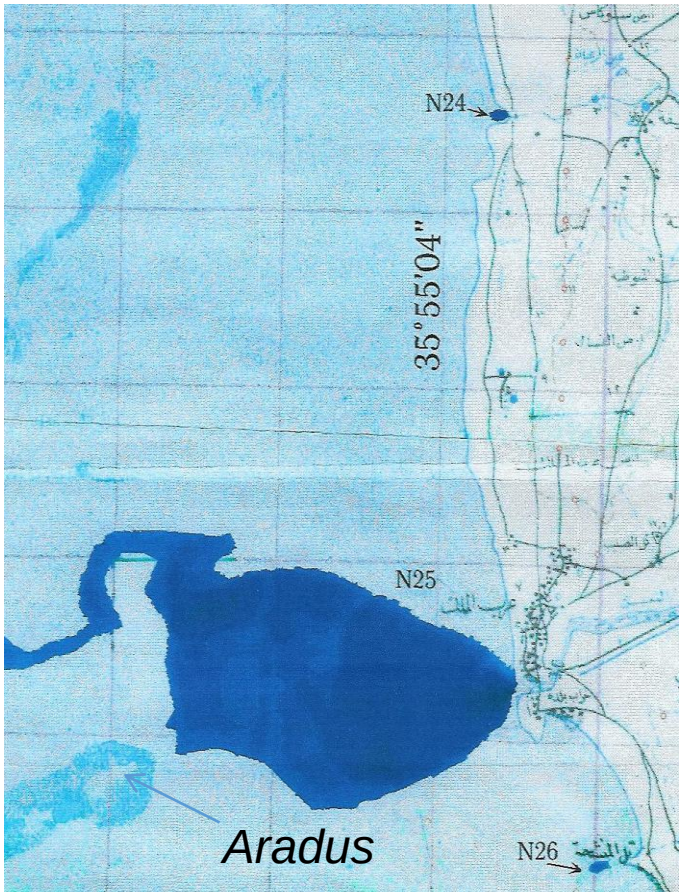
- Russian geophysicists discover previously unknown accessible freshwater sources on Syrian coast, changing local and regional sustainability.



Is this a new discovery?

Upwellings: Syria

- Russian geophysicists discover previously unknown accessible freshwater sources on Syrian coast, changing local and regional sustainability.



The Geography of Strabo: Book XVI, Chapter 2
- Early 1st Century A.D.

"Aradus lies off a surfy and harbourless seaboard; it lies approximately between its naval station and Marathus, and is twenty stadia distant from the mainland. It consists of a rock washed all round by the sea, is about seven stadia in circuit, and is full of dwellings; and it has had such a large population, even down to the present time, that the people live in houses with many stories. It was founded, as they say, by exiles from Sidon. They get their water-supply partly from the rains and cisterns and partly from their territory on the mainland. ***In war-times they get water from the channel at a short distance in front of the city. This channel has an abundant spring; and into this spring the people let down from the water-fetching boat an inverted, wide-mouthed funnel made of lead, the upper part of which contracts into a stem with a moderate-sized hole through it; and round this stem they fasten a leathern tube (unless I should call it bellows), which receives the water that is forced up from the spring through the funnel. Now the first water that is forced up is sea-water, but the boatmen wait for the flow of pure and potable water and catch all that is needed in vessels prepared for the purpose and carry it to the city."***

Upwellings: Southern California

- Described by Stephan Riess:

About 1941 or '42 a neighbor, within a few miles of my home in Simi Valley, realized that his irrigation water was constantly depleting and going down in his wells asked me to find him, if possible, a new water well site. I did. I went up to the adjacent mountain there, out of the valley of course, and drilled two wells which are still going today. This created a closer relationship with that friend of mine who owed around 500 acres of orange grove. He was originally from Denmark. He grew up along the seashore there and if he didn't get near salt water once a month or twice a month he wasn't feeling well. So he invited me to go with him out fishing off Hueneme right here on the coast. He had a little boat with a outboard motor. And off we went out to sea. About oh maybe a mile and a half or so out he pulled out a paper cup from his bag dipped it in some water and drank. And he offered me a cup. And I of course couldn't get the idea why a fellow would want to drink so much seawater. He's finished a whole little plastic cup he had. He offered it to me and he said "try it, it's awful good water." And watching him drinking that with pleasure apparently, I couldn't image how a man could drink that seawater as he did. And I tried it. And sure enough to my surprise it was good, sweet, drinkable water. So he said, "didn't you know this thing here?" I said "no." He said, "well there is an enormous amount of good water coming up the ground, below the seawater and it's surfacing here." And he said, "that was known in the earliest days to the sailing ships, the ships that used to come here to pick up the grain that then was grown in Simi Valley and other places, and the whaling ships and the fur traders used to come here to fill up their tanks before they went up north. It's thoroughly recorded and mapped by the Jesuits in the earliest days of California. The documents you will find from the Jesuits are in the museum in Spain today." Which is correct. They are there because I checked on it. And I noticed that there was a circle of possibly oh a half a mile across that contained that sweet water in the midst of the salt... sea, of the salt and sea water welling up with a slightly different coloration or reflection when the Sun was shining on it. This baffled me and I wanted to follow it up. So I did.

Upwellings: Southern California

INTERNATIONAL ATOMIC ENERGY AGENCY
VIENNA 1962

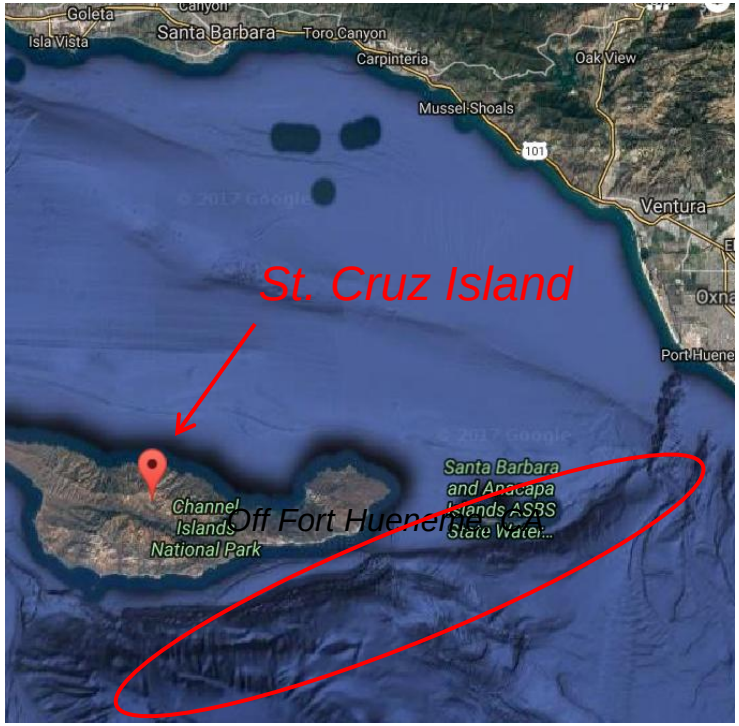
TRITIUM GEOPHYSICS: RECENT DATA AND RESULTS*

W. F. LIBBY ★
DEPARTMENT OF CHEMISTRY AND INSTITUTE OF GEOPHYSICS
UNIVERSITY OF CALIFORNIA, LOS ANGELES, CALIFORNIA
UNITED STATES OF AMERICA

TABLE III
PACIFIC (SOUTH OF SANTA CRUZ ISLAND OFF CALIFORNIA COAST) SAMPLES FROM K. O. EMERY, U. S. C.

		T. U.
Lat. N. 32°50.2′	Long. W. 119°42.2′	1.8 ± .3 0.55 ± .4
Lat. N. 31°52′	Long. W. 120°26′	1.6 ± .2 0.9 ± .2

From these data it appears to be very probable that these two points over 75 miles apart, about 100 miles off the lower California coast, are in a large upwelling area such that the water is very largely from the depths with only a small component of recent surface water. Further measurements must be undertaken to elucidate the extent of this area. Professor Emery submitted these samples for the reason that he expected the first to show upwelling. The second was collected as a control point, but it, too, apparently lies within the area.

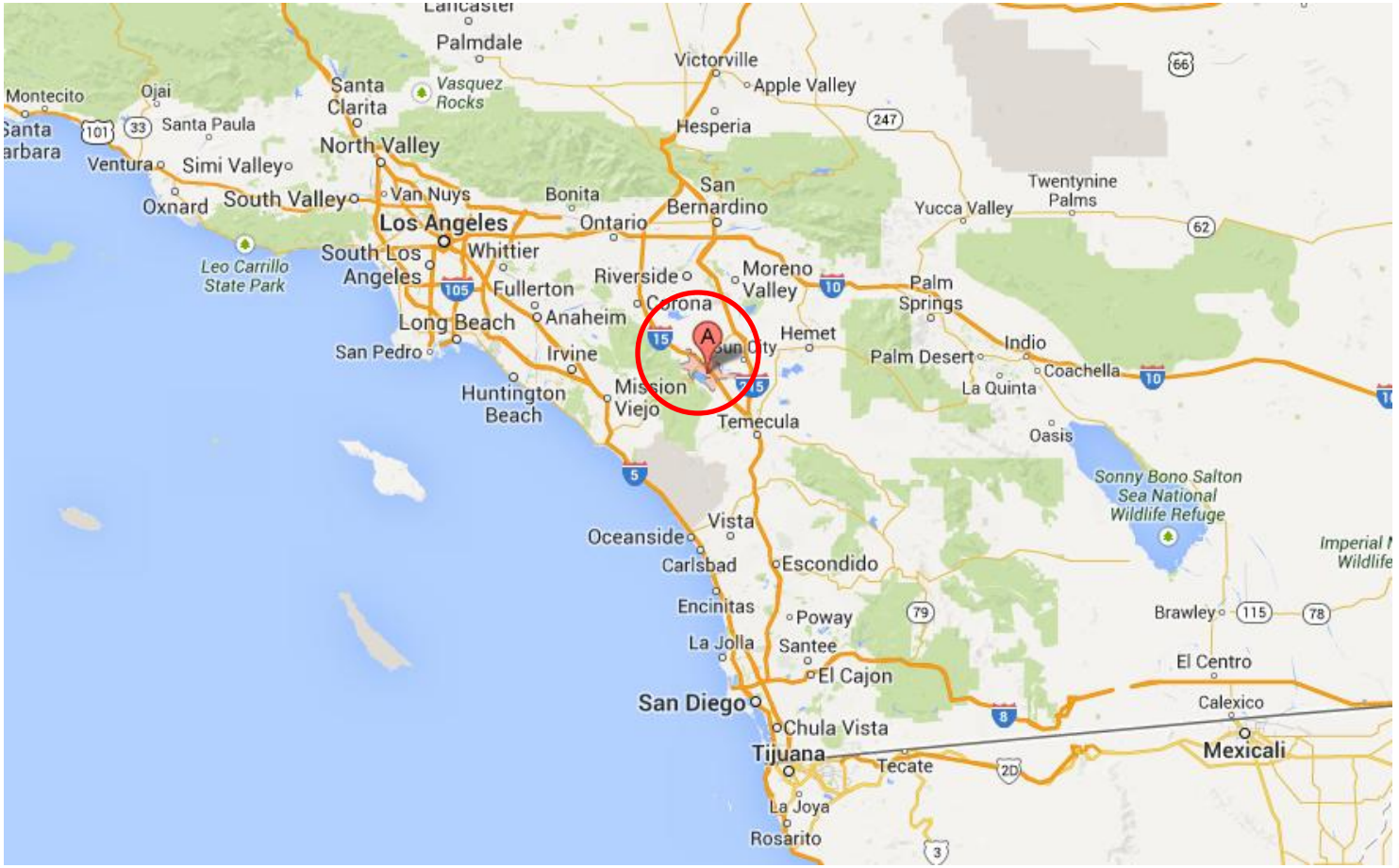


★*Libby, a PW proponent, was awarded the Nobel Prize in Chemistry in 1960*

Primary Water Case Study

- An “extended drought” from 1947 - 1957 left a wind-blown, dusty, dry lake bed. Bill Cox, President of Water for Lake Elsinore Association, joined Director Mathew Yax and **Verne L. Cameron, pioneer Primary Water explorer**, in appraising Cameron's 1952 lake development plan.

Case Study: Lake Elsinore, CA



Case Study: Lake Elsinore, CA

- The first Lake Elsinore Well tested a consistent flow of **5,500 gallons per minute** from a deep seated Primary Water source. Two nearby wells also capable of 5000+ gpm, along with limited rainfall and flood runoff, combined to produce a stabilized lake approximately 3 miles x 1.5 miles.

Case Study: Lake Elsinore, CA

- Lake Elsinore was fully restored due to the innovative work and skill of Verne Cameron and Bill Cox

Case Study: Lake Elsinore, CA

- Lake Elsinore, California survives today on the primary water wells sited and drilled **55 years ago**!

Case Study: Lake Elsinore, CA

- Lake Elsinore, California survives today on the primary water wells sited and drilled **55 years ago**!

http://www.utsandiego.com/news/2010/Oct/18/forum-lake-elsinore-a-success/

"To help stabilize lake levels at Lake Elsinore, the authority restored three groundwater wells [in 2004] that provide **more than a billion gallons of groundwater annually** through the Lake Elsinore Island Wells Project."

PRIMARY & ATMOSPHERIC WATER CYCLES

ATMOSPHERIC WATER CYCLE DRIVEN BY SOLAR ENERGY

Hydrologic Cycle driven by Solar Energy

PRIMARY WATER CYCLE

Natural PW Spring

PW Well Drilling at depth of 200 - 800 ft

Permeable surface

Polluted Aquifer

Reservoir fed by runoff & Primary Water

Runoff

Water Evaporation

Lake from Runoff & Primary Water

Aquifer from Runoff & PW

Aquifer Well

Earth Crust Rock Formations

Primary Water Drillings Rigs

Ocean

Fresh Water Springs/Vents

Seawater Intrusion

Volcanic Eruptions release Water Vapors

Surface Hot Spring

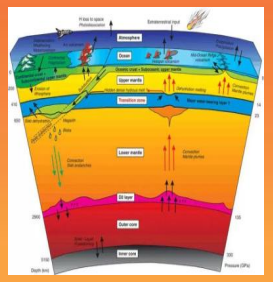
Fault lines filled with Primary Water

River fed by Primary Water & Runoff

Primary Hydrologic Cycle driven by Earth Energy

Primary Water is created deep within the Earth from the synthesis of hydrogen and oxygen. Under tremendous pressure from Earth's internal heat, H_2O, in the form of vapor, is forced upward through rock fissures (weakest areas of Earth's crust) becoming liquid as it cools. Primary Water is forced upward, while atmospheric water is subject to the effects of gravity and flows downward.

Mantle contains H_2O



The Primary Water Institute

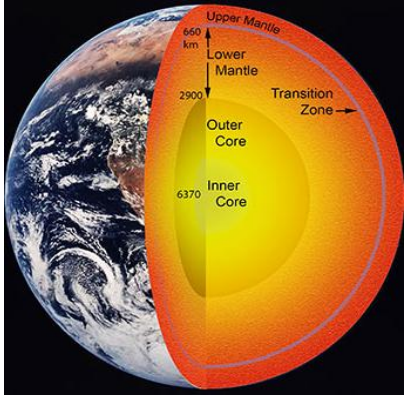
www.primarywaterinstitute.org

Copyright: Primary Water Institute 2015

Graphics: www.hedi-label.com

Image not to scale

Some References



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http://adsabs.harvard.edu/abs/2002AGUSM.M42A..04S

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Life-giving rocks from a depth of 250 km (2007)

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Found: The hottest water on Earth (2008)

https://www.newscientist.com/article/dn14456-found-the-hottest-water-on-earth/

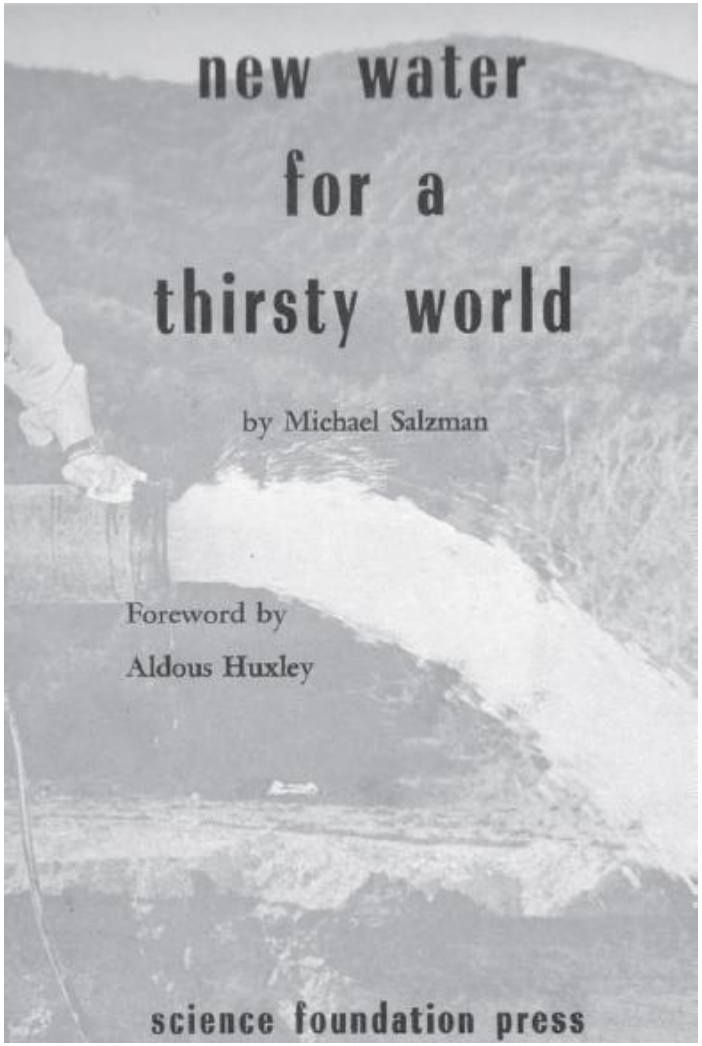
Tiny diamond impurity reveals water riches of deep Earth (2014)

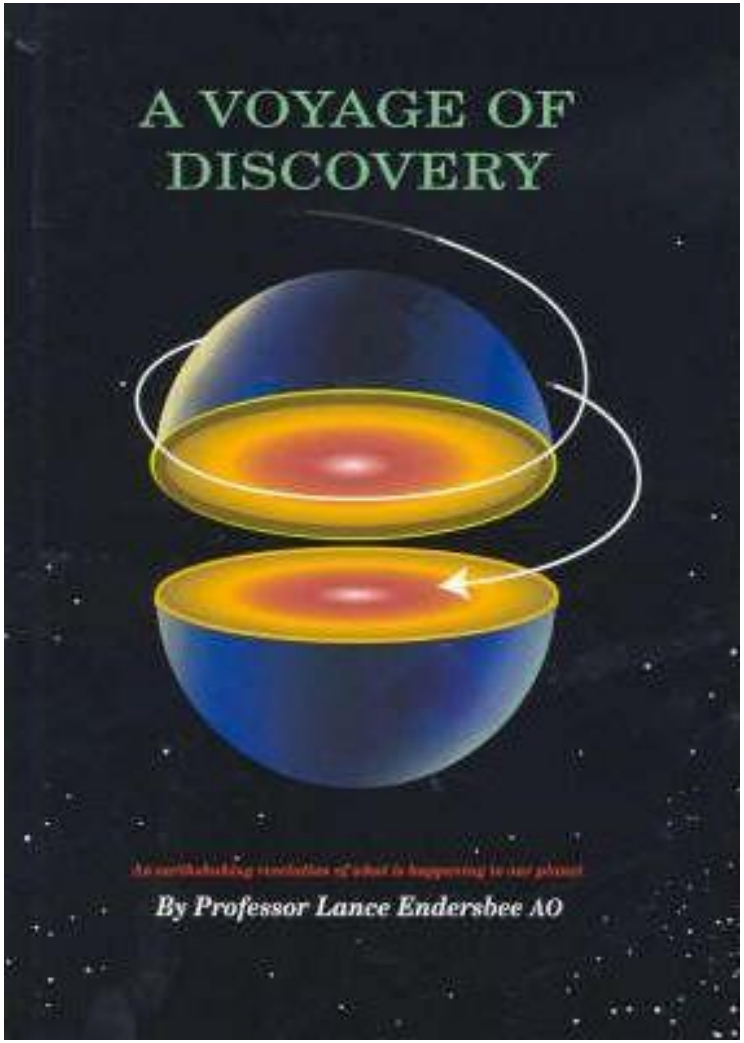
http://www.nature.com/news/tiny-diamond-impurity-reveals-water-riches-of-deep-earth-1.14862

Planet Earth makes its own water from scratch deep in the mantle (2017)

https://www.newscientist.com/article/2119475-planet-earth-makes-its-own-water-from-scratch-deep-in-the-mantle/

Further Reading on Primary Water





The Challenge of the Interlopers

"The inertia of the human mind and its resistance to innovation are most clearly demonstrated not, as one might expect, by the ignorant mass--which is easily swayed once its imagination is caught--but by professionals with a vested interest in tradition and in the monopoly of learning. Innovation is a twofold threat to academic mediocrities: it endangers their oracular authority, and it evokes the deeper fear that their whole, laboriously constructed intellectual edifice might collapse. The academic backwoodsmen have been the curse of genius from Aristarchus…; they stretch, a solid and hostile phalanx of pedantic mediocrities, across the centuries."

- Arthur Koestler, *The Sleepwalkers (1959)*

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