Hydrogen Future Alberta

www.BillHowell.ca - for Perry Kincaid webinar 31Mar2022

- This short presentation seeks to :
  - avoid overlap with Alberta Associate Minister of Natural Gas - Dale Nally
  - cover a few interesting points
  - stimulate discussions, rather than proclaim the answer
- Safety and hydrogen - good news
- Economics and Risks (X)
- Alberta roadmap - selected ideas (X)
- [random, scattered] concepts
- Fun, crazy stuff

A description of this video project, plus access to all files related to this video can be accessed through the link at the bottom of the slides. This includes [webPage, video, slideshow, image, reference list, selected reference, script, etc]s.

Personal bias - (*) marks concepts in following slides that I've come across in past jobs, projects
slides to skip (X) - 10 min time constraint does not allow for presentation, but still in slide show

Safety and hydrogen

- At first glance - hydrogen is pretty mean stuff
- Second glance - do-able + some advantages?
- Big difference between [trained, professional] operations and the public - car companies are good at this
- Global [research, development, piloting, standards] (roadmap)
- Example - Undergound hard-rock mining fuel cells (*)
- Example - School bus pilot project in USA (X)

Safety and hydrogen

At first glance - hydrogen is pretty mean stuff

Safety properties of gases

fuel	chemical formula	normal boiling point (°C)	density NTP (kg/m^3)	flash point (°C)	autoignition T (°C)	velocity flame (m/s)	explosive limits (% by volume in air)		
							lower		upper
hydrogen	H2	-253	0.0838	<-253	585	2.83	4		75
methane	CH4	-162	0.668	-188	540	0.45	5		17
ammonia	NH3	-33.4	0.771	132	630		15		28
propane	C3H8	-42.1	1.87	-104	490	0.46	2.1		10.1
ethane	C2H6			-135	515		3		12.4
ethanol	C2H5OH	78.5	789	13	423	n/a	3.3		19
gasoline	n/a	27-225	751	-43	230-480	n/a	1.2		7.1
diesel fuel	n/a						0.6		7.5

methane ~= natural gas; octane ~= gasoline; cetane ~= diesel; (explosive = flammable) limit
NTP = normal temperature & pressure, 20 °C and 1 atmosphere
velocity flame (m/s) = maximum flame velocity in air (m/s)
watch out for my [misread, typo]s!!

Mercaptan-like safety (stench)
- is there an equivalent yet for high-purity fuel cell hydrogen?
- easy for hydrogen-fuel mixes? (15% mentioned by roadmap)

hydrogen "invisible flame" to naked eye
asphixiant gas (like most other gaseous fuels)
easy leakage, hydrogen embrittlement of metals
Demo explosion at a lab shocked me for sure - quite a bang! - danger of reactions

Safety and hydrogen

Second glance - do-able + some advantages?

high diffusivity - dissipates extremely rapidly
no toxicity rating, as with many other fuels
well-established safety protocols as a starting point
new [research, pilot, demo, codes & standards] for new applications

I remember the comment of hydrogen safety experts :

- tests of firing bullets into pressurized hydrogen tanks failed to ignite any of them

There can be some safety advantages of hydrogen over [gasoline, diesel]?

- closed work environments : particulates, NOx, rapid dispersion of leak (when ventilated!)
- slow release from H2 storage materials (then again, possible BLEV-style release?)
- still - they are BOTH dangerous. But we know how to live with gasoline.

Safety and hydrogen

Example - Underground hard-rock mining fuel cells (*)

Driving forces :

- Green House Gases (GHG)
- diesel exhaust regulatory directions [particulates, NOx,etc]
- operating costs [ventilation, maintenance, automation]

Technical Committee	Advisory Committee	Stakeholders	Facilitators
Air Liquide Barrick IAMGOLD Vale INCO Xstrata Nickel Raglan	A.V.Tchouvelev & Associates Hatch Université du Québec à Trois-Rivières, IRH Paceas Technologies Washington Safety and Management Systems	Chief Inspectors MSHA Trade Unions Equipment Manufacturers	SOREDEM CANMET-MMSL

From Marc Betournay presentation, NRCan

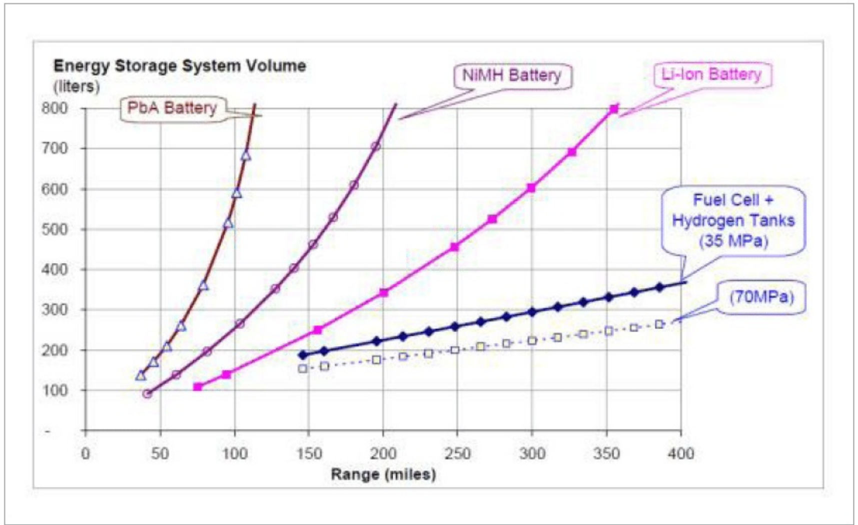
Economics and Risks (X)

- Will "blue hydrogen" (natural gas based) be accepted after 2050?
- Will hydrogen fuel cells be a strong competitor of batteries for passenger cars? for trucks?
- [USA, Russia, China, India, Arab, Persia, other] "upstream" competitors
  - they are not going to be restrained as Alberta has been?
- substitute "energy carrier" technologies (later slide)
- Crushing new priorities, FAR beyond all this??! (**)

Economics and Risks (X)

- Will hydrogen fuel cells be a strong competitor of batteries for passenger cars?
- For comparison to today's living, it's essential to know CO2 taxes, effect of heavier EV batteries, actual [battery, fuel cell] life, city vs highway, subsidies, etc etc?
- Energy efficiency of EVs : battery 70-80%, fuel cell 25-35% via electrolysis
- don't trust numbers until you've looked [broadly, closely] and did your own estimates!

Garrett Motion - battery small vehicles, fuel cell larger



PbA = lead acid; NiMH = nickel metal hydride; Li-Ion = lithium ion; MPa = megapascal, a unit of pressure (1MPa = 145 psi). Source: Cadex Electronics (CH)

University of Alberta (from roadmap, are CO2 credits involved?)

FIG. 1: 2020 GLOBAL HYDROGEN PRODUCTION COSTS

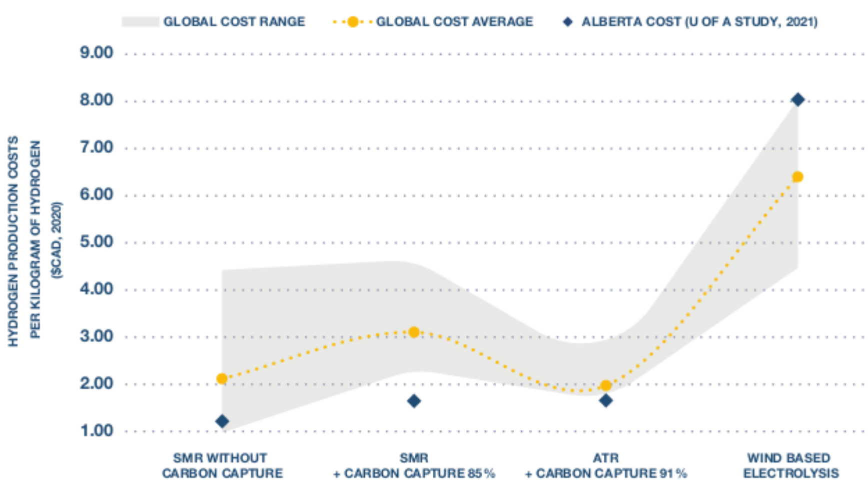


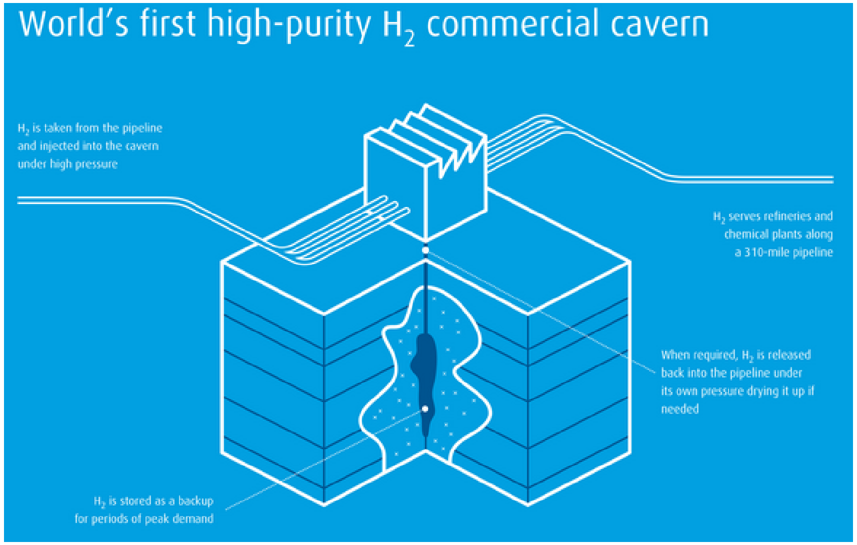
Figure 1. Alberta's hydrogen production costs against global averages. Hydrogen production costs vary depending on facility size, type, feedstock, and energy use.[17]

Alberta roadmap- selected ideas (X)

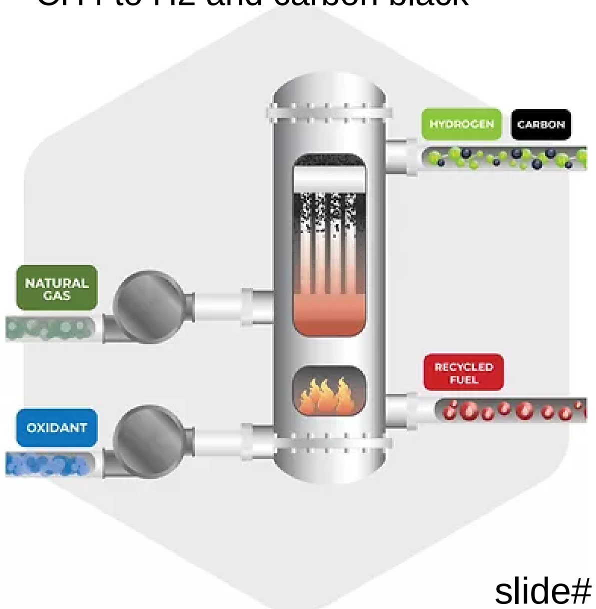
(ideas that have been around, but with advances)

- Natural Gas Decomposition (NGD) – thermal decomposition of methane into hydrogen gas and solid carbon (also known as carbon black), then a direct carbon fuel cell
- Underground Gasification (UG) – of [crude oil, bitumen, coal] integrated with Carbon Capture and Underground Storage (CCUS)
- Can some Alberta natural gas storage (salt formations) be <u>adapted</u> to hydrogen? (**)

Linde , Texas



Ekona Power -
CH4 to H2 and carbon black



[random, scattered] concepts

(there is no end to the ideas... most ideas here very old)

- Hydrogen [combustion engines, turbines] for transportation? (roadmap) (*)
- [battery, fuel cell, flywheel, ultra-capacitor] comparison (*) (X)
- Caterpillar's global initiative for electric battery huge mining trucks
- your hydrogen fuelcell car as an electric power generator for the grid? (*) (X)
- Fischer-Tropsch-like processes : coal to [gas, oil, hydrogen, other] (*) (X)

Caterpillar, Teck, BHP

[random, scattered] concepts

[battery, fuel cell, flywheel, ultra-capacitor] comparison (*) (X)

- Catalysis, materials, sensors, micro-electronics, controls - can be game-changers
  - thermal management, fabrication, costs, overall system efficiency etc
  - life cycle analysis (wrong phrase!) - always problematic
  - IF rare lab results can be translated into viable product ... ?
    - seems to be common in electrochemistry, photo-voltaic
    - [solid, liquid, gas, but also plasma?] = "Earth, water, air, fire" of ancient Greece?
  - [poorly known, new] * [science, technology] "dark horses"
    - can upset the apple-cart and ruin massive investments?
- Flywheels
  - fascinating company in Ottawa years ago (*)
  - safety issues & "asymmetry of perceptions" of technologies?

[random, scattered] concepts

ultra-capacitors - one of those "dark horses"? (*) (X)

Image : US-DOE presentation, 10Jun2010
2019 lab results : China-Korea paper thiol-functionalized, nitrogen-doped, reduced graphene oxide scrolls

Why Ultracapacitors?

Strengths

- High specific power → Good for power assist
- Fast charge acceptance → Good for regenerative energy capture
- Excellent cycle life → Fewer replacements required
- Excellent low temperature performance → Good for engine start

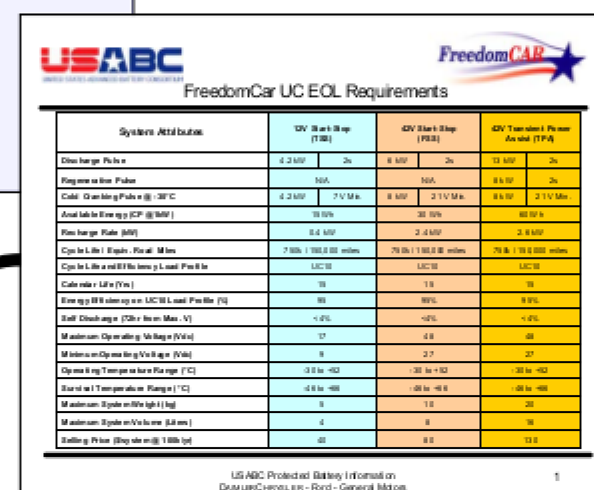
Weaknesses

- Low specific energy → Limited operational time
- High self discharge → Requires frequent charge

Advantages of Hybridizing Battery and Ultracapacitor

- Reduces battery operating current. Lower I^2R heating.
- Reduces power pack weight.
- Extends battery life. Reduce replacement cost.
- Better low-temperature performance for cold engine starts.

Energy Density: 3 Wh/kg
Power Density: 650 W/kg
Operating Range: -30 to +52°C
Survival Range: -46 to +66°C
Cycle Life: 750,000 cycles



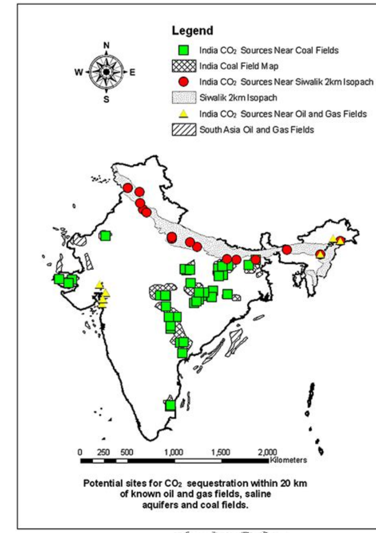
	2019 lab results ultracap		cellphone Li-ion	
@A/g	0.25	50		
Wh/kg	206	32	100-265	-->
W/kg	496	~10	~250-340	-->

lab results will be far less in a battery pack!!!
vehicle packs will be lower than for cellphone battery

[random, scattered] concepts

Fischer-Tropsch-like processes : coal to [gas, oil, hydrogen, other] (*) (X)

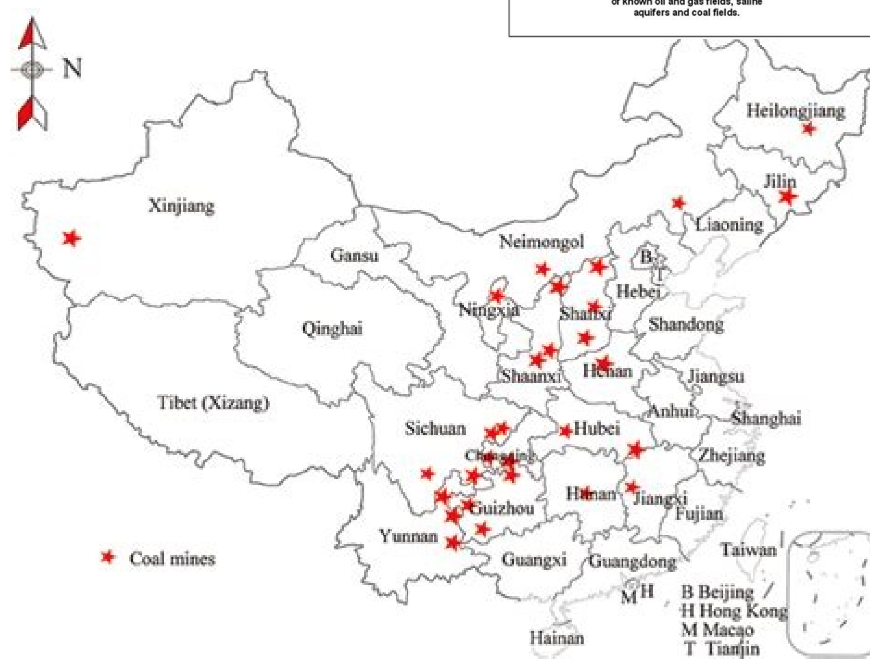
historical operations [WWII Germany (*), South Africa]
China ~2010-ongoing? : ceased or carbon capture?
India - intent to expand gas storage even before Ukraine
    2019 India reluctance for CO_2 storage
coal plant in a bottle (like sailing ships), O_2 enrichment (*)
recently, USA coal to [acetylene, ethylene] (strange?)



Environmental Defense Fund 2019
Underground Gas Storage in China
Figure1 - China's Gas Network

https://tse2.mm.bing.net/

Source: Cedigaz



Multi-edged heresy? (X)

For the next slide, almost all (except ~<1:100) [government, academic] research scientists are perhaps best advised to roll their eyes and walk away, if they don't climb up a wall first.

It's all they [can, should] do?

But I'm looking for essentially none (<1:10k) of the scientists, and none for all [theories, time].

So strange that so many of the so few turn out to be amateurs.

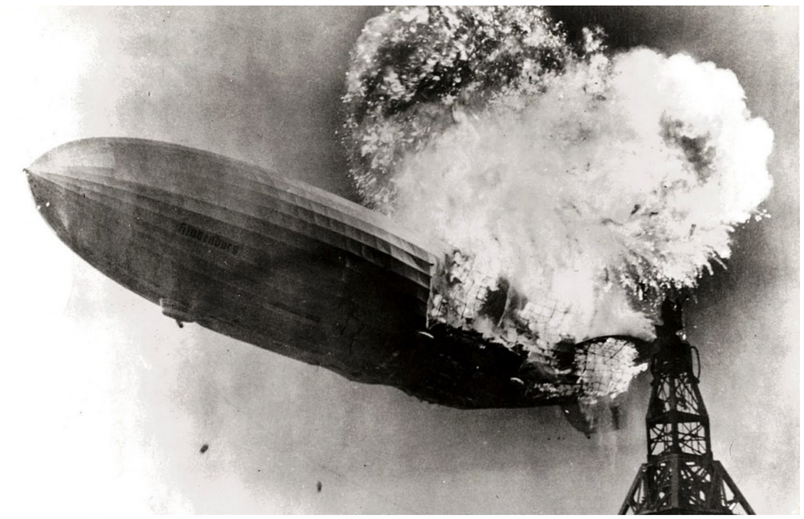
"multiple conflicting hypothesis" to avoid the trap of becoming a tool of concepts, rather than the concepts being a starting environment to play with

[right, wrong, true, false] are not so relevant. I'm mainly interest in finding a strong thinker, and if I'm really lucky, a [creative, revolutionary, breakthrough] thinker.

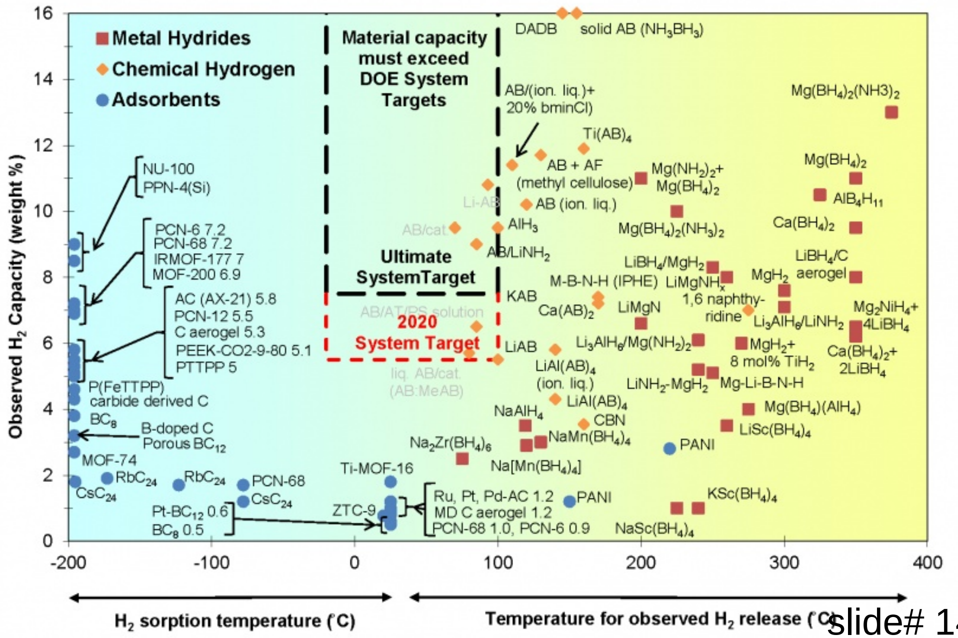
Fun, crazy stuff (X)

(% = things I've come across in the past with my personal projects, definitely NOT accepted by mainstream science!)

- % Randell Mills hydrino - fractional electron quantum levels? (*)
- % Aureon.ca in Toronto - mythology inspired, electric sun experiments (*)
- Stairway to heaven? - Zeppelins for hydrogen transport in the North, riding the jet streams (X)
- *Joke* : best hydrogen [storage, transport] is to attach it to long carbon chains or oxygen!
  - joking aside, **there are wonderful developments for better hydrogen storage**
  - one example in roadmap - ammonia as a carrier for export



USA Office of Energy Efficiency and Renewable Energy



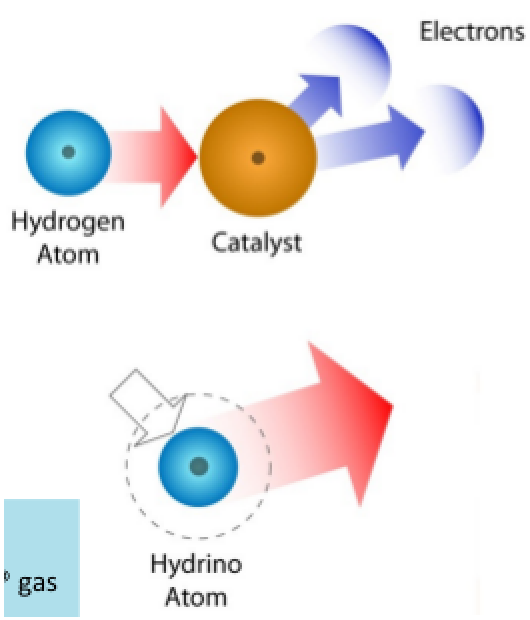
Randell Mills hydrino

Electron fractional quantum levels? (*)

Mills has MANY critics!!! - probably any scientist that looked at it since 1986-91
My lesson over decades across subjects, one often finds that :

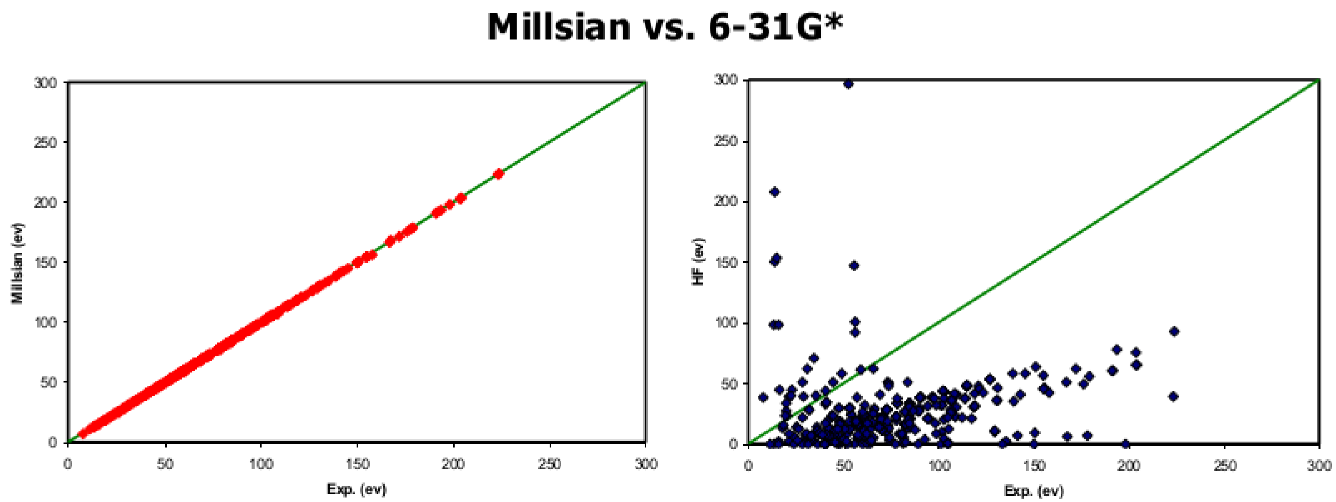
Great work is greatly hated, follow the outcries to find the truly exceptional

BrilliantLightPower.com hydrino catalytic reaction releasing heat



Comparison of Classical to Quantum Mechanical Performance

The total bond energies of exact classical solutions of 415 molecules generated by Millsian 1.0 and those from a modern quantum mechanics-based program, Spartan's pre-computed database using 6-31G* basis set at the Hartree-Fock level of theory, were compared to experimental values.



R. L. Mills, B. Holverstott, W. Good, A. Makwana, J. Paulus, "Total Bond Energies of Exact Classical Solutions of Molecules Generated by Millsian 1.0 Compared to Those Computed Using Modern 3-21G and 6-31G* Basis Sets," Phys. Essays 23, 153 (2010); doi: 10.4006/1.3310832

Randell Mills hydrino

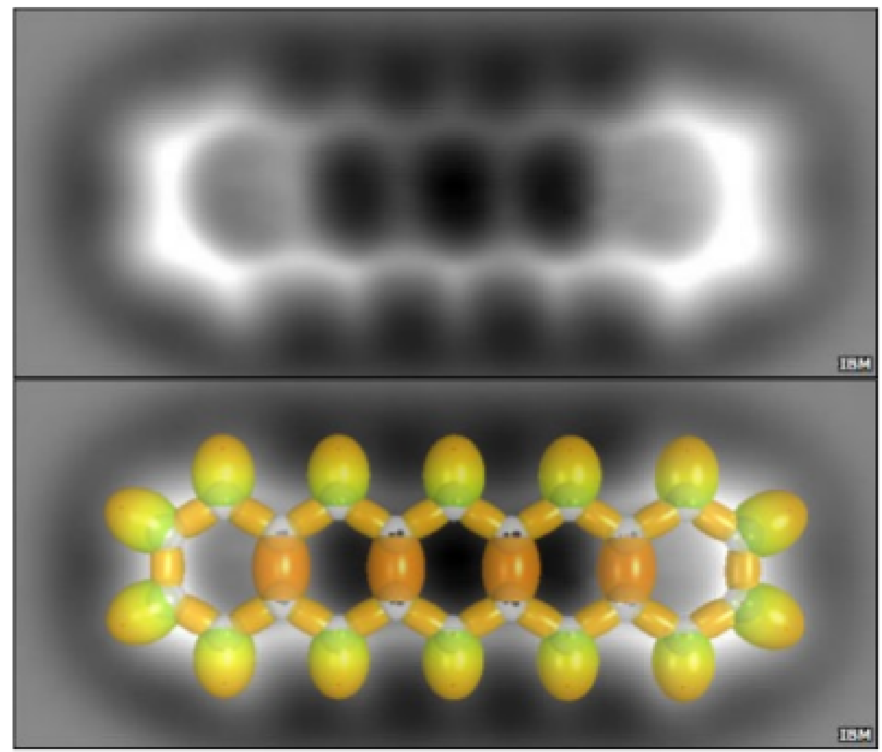
Chemical bonds - not your quantum fuzziness?

Physical Image Compared to Physical Solution

brilliant LIGHT POWER

The polycyclic aromatic hydrocarbon pentacene was imaged by atomic force microscopy using a single CO molecule as the probe. The resulting breakthrough in resolution revealed that in contrast to the fuzzy images touted by quantum theoreticians as proof of the cloud model of the electron, the images showed localized bonding MOs and AOs in agreement with the classical solution.

Top, atomic force microscopy image of pentacene by Gross et al. Bottom, the superimposed analytical classical solution that matches the physical structure.



[L. Gross, F. Mohn, N. Moll, P. Liljeroth, G. Meyer, "The chemical structure of a molecule resolved by atomic force microscopy", Science, Vol. 325, (2009), pp. 1110-1114.]

Randell Mills hydrino

Water to fuel your car (*)

Hydrino®: Energy Release of 2.78 GJ (800 kWh)/ L of Water

200 times the energy of burning the equivalent hydrogen

1 pellet of uranium (10-30g) = 17,000 scf natural gas 149 barrels of oil 1 ton of coal

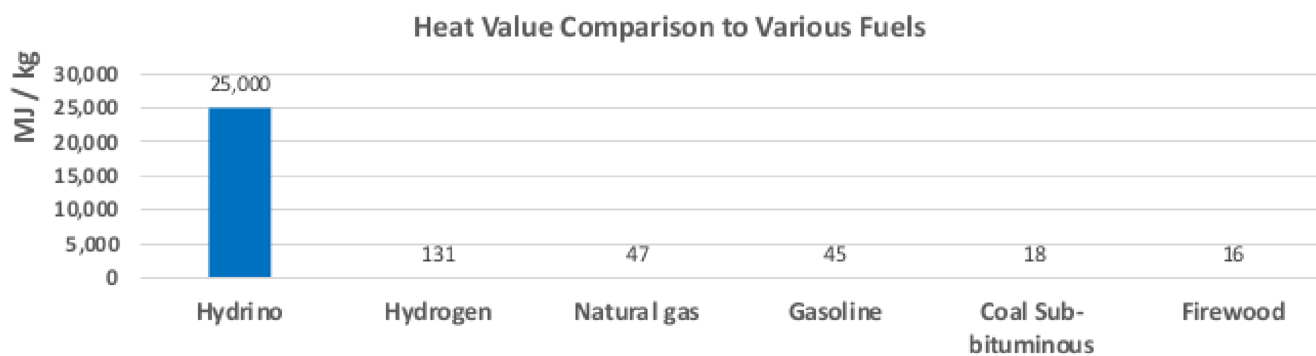
1 liter of water or H_2 (200 atm)

0.8 MWh of wind turbines

0.45 bbls (72 liters) of crude oil

0.13 tons of coal

2200 miles for a Tesla S



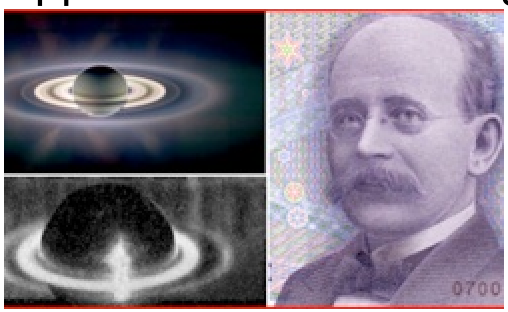
brilliant LIGHT POWER

40

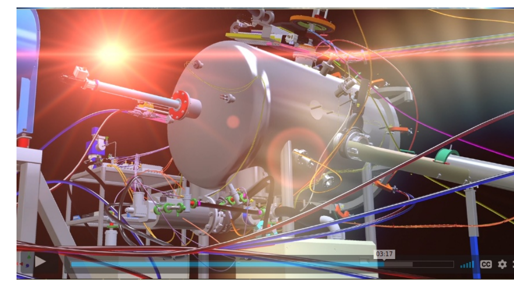
SAFIRE, Aureon.ca

mythology inspired, electric sun experiments (*)

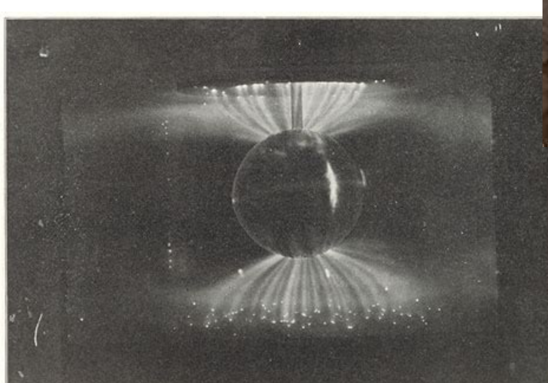
THE SAFIRE REACTOR
After almost a decade of research and experimentation, the SAFIRE PROJECT team developed a stable medium-energy plasma reactor. Using a process called Nuclear Valence Excitation (NVE) the SAFIRE reactor can generate safe and uniquely controllable nuclear changes. This technology has many potential applications in the energy and cleantech industries.



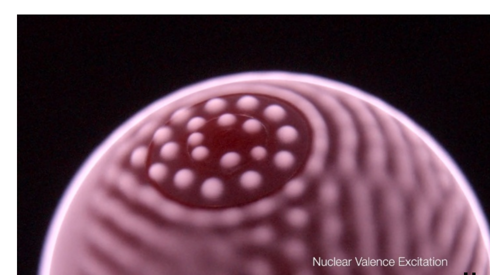
<- Terrella experiments
|
V



Kristian Birkeland
(December 13, 1867 —
Jun 15, 1917)



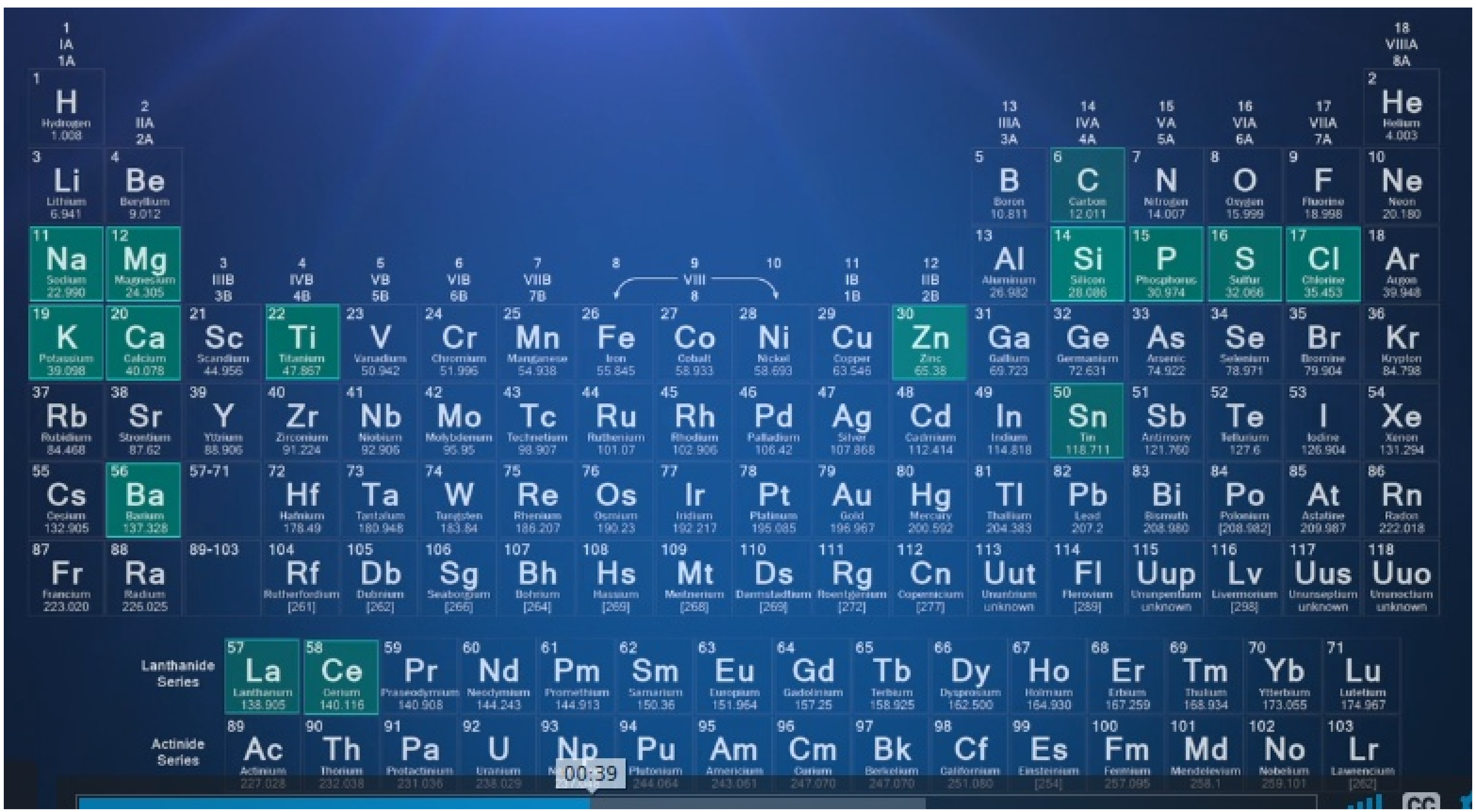
SAFIRE -> electric sun



"de-radio-activation" of materials (*)

We are now creating the first commercial application of the NVE technology to eliminate the radioactivity from the wastewater of hydraulic fracturing operations called produced water. (...high-level fission waste later?...)

Elements produced in the SAFIRE hydrogen plasma vacuum reactor. The Standard Model of the Sun suggests only [helium, lithium]. Removal of radio-activity : either increase or decrease atomic number, depending on isotopes? NOTICE : Rare Earths, a target also!



SAFIRE, Aureon.ca

"de-radio-activation" of materials (*)

21Nov2020 https://aureon.ca/ SAFIRE video (since replaced with newer aureon videos)
Hand-written comments from the video (approximate) :
"... MIT has found that when radioactive waste is exposed to hydrogen isotope nuclei, the decay rate of the radioactive material can be accelerated, even to the point of neutralising the radio-activity. ..."
"... SAFIRE would also use radioactive materials as fuel, and the elemental transmutation would remediate the radiactive waste back into the base elements, and render it benign. Right now there are 450 successful nuclear fission plants on the Earth. Imagine if they could produce energy without creating radiactive waste. ..."

31Mar2022

slide# 20

http://www.BillHowell.ca/Bill Howells videos/220331 Hydrogen future Alberta/Howell - hydrogen future Alberta.html

Immanuel Velikovsky, David Talbot, Wal Thornhill, Anthony Peratt

[psychiatrist, mythologist, physicists] and

petroglyphs (*)(X)

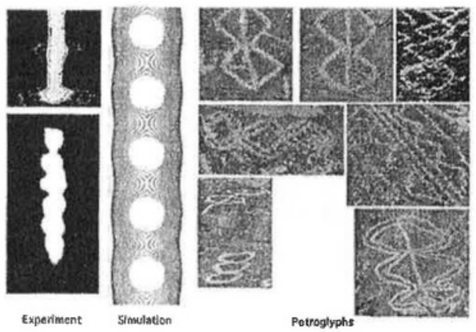


Fig. 16. Pinch instability characteristics of a plasma column. (Left) Plasma light photographs, early time. (Middle) Graphical solution of the Chandasekhar–Fermi equations. (Right) Petroglyphs. The patterns are found world-wide.

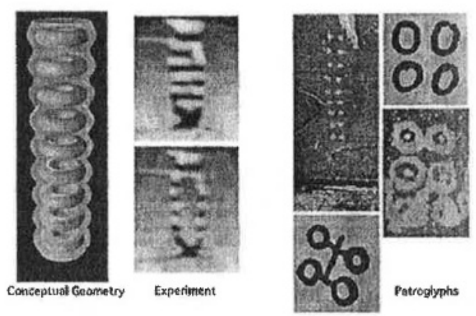


Fig. 17. Conceptual geometry of a stack of nine plasmoids produced in a high-current plasma column. (Left) Experimental and conceptual data of a stack of toroids along the pinched plasma column. (Right) Petroglyphs depicting stacked toroids. Note that the double row of dots numbers nine, the exact number of toroids generally produced in a plasma pinch.

and the duration and location of a current pulse propagating along the column. Because of the time required to produce certain classes of morphologies of petroglyphs and also the precipitousness of location, we conclude that petroglyphs were produced during daylight conditions, perhaps twilight or dawn. This then allows an estimate of the luminance necessary to see auroral plasma phenomena.

1) Spheroids: The petroglyphs in Fig. 16 accurately portray the outer spheroid isophotes, some including the central visible

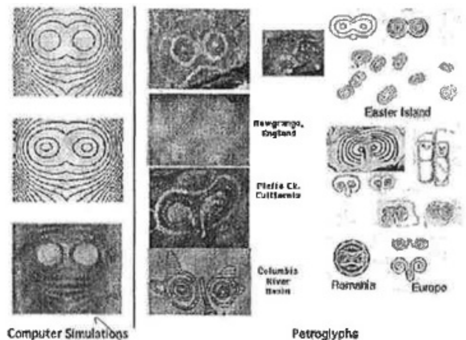


Fig. 18. Eye and nose masks. (Left) Isophotes from a portion of the graphical solution of the Chandrasekhar–Fermi equations. (Right) Eye mask and prominent nose petroglyphs.

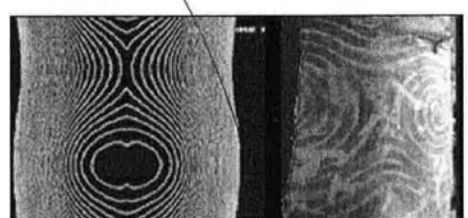


Fig. 19. Face masks as collected from various locations on Earth. The figure at the top left is a portion of the graphical solution of the Chandrasekhar–Fermi equations.

Cool!

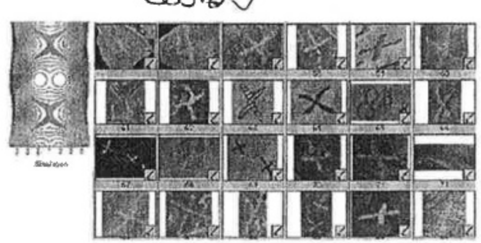


Fig. 20. Separatrix magnetic field merging crisscrosses. (Left) Portion of the graphical solution of the Chandrasekhar–Fermi equations.(Right) Assortment of petroglyph criss-crosses.

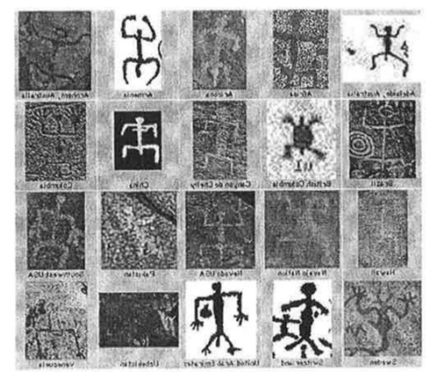


Fig. 30. Commonality of the most often depicted petroglyph, the squatter human or anthromorph.

duration of sporadic current pulses within the auroral plasma column, and the orientation of a column undergoing nonazimuthally symmetric motions.

While the previous figures have suggested that the phenomena was universally seen, what could be observed would depend on the observer's location on Earth and whether or not the entire column was visible or illuminated, or some portion of it, as in auroral displays today.

Fig. 30 is a collection of one of the common petroglyphs as

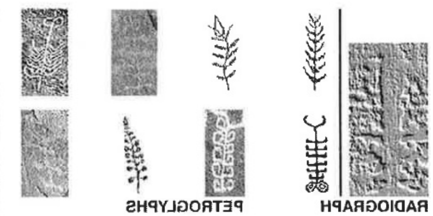


Fig. 28. (Left) Laser back-illuminated plasma pinch. The photograph has been digitally stratified to bring out the curling of the edges of the bottom, flattened toroids. The cathode is at the top. (Right) Sample collection of petroglyphs showing the transition from the ladder phase of the instability to toroid vortices. (Left to right, top to bottom). The examples shown have been collected from several parts of the world.

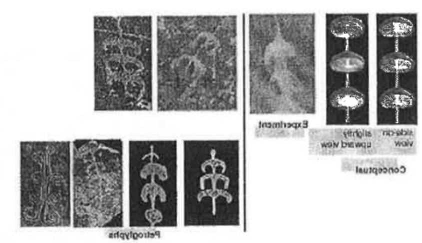


Fig. 29. (Left) Vortex formation in sub and multimegaampere pinched plasma columns. (Right) Petroglyphs.

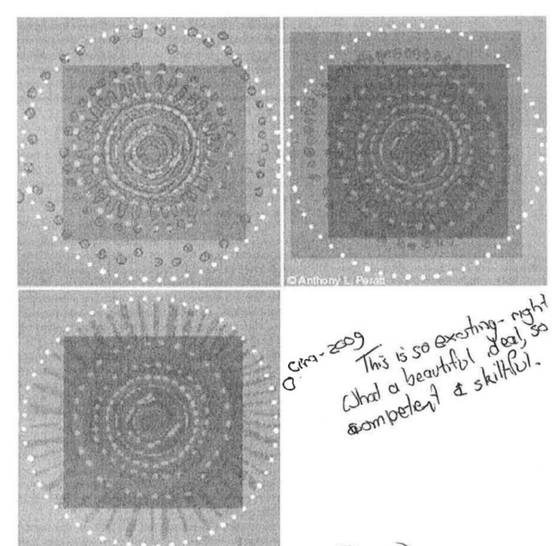


Fig. 46. Overlays of petroglyphs and a pictograph (gray) with a reconstruction image of Stonehenge (white). (Top Left) 4 O'Clock Rapids petroglyph on the Columbia River in the state of Washington. (Top Right) J. D. Bar pictograph, Columbia River. (Bottom Left) Northern Arizona petroglyph. The 4 O'Clock Rapids petroglyph is about 60 cm in diameter while Stonehenge is approximately 100 m in diameter.

circa-2009 This is so exciting - right or wrong, What a beautiful ideal, so creative competent & skillful.

Anthony Peratt 2003 paper

Anthony Peratt

Petroglyphs - chaos across the globe? (X)

Fig. 21. Photograph of the Zanskar River looking down to one of the petroglyph sites illuminated by a narrowband of sunlight.

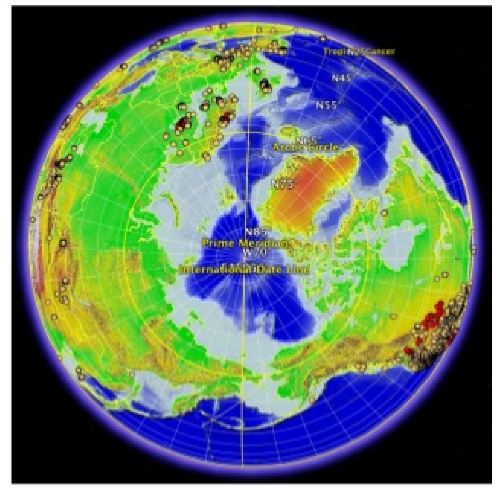


Fig. 2. Arctic map distribution of petroglyphs and pictographs.

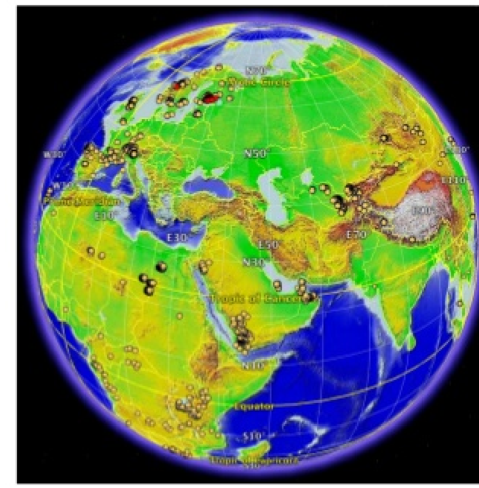


Fig. 4. Petroglyph and pictograph distributions for Europe, Middle East, and Asia. Globe centered on the Tropic of Cancer.

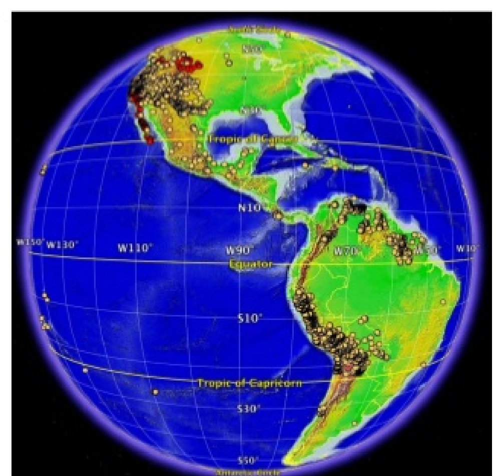


Fig. 3. Petroglyph and pictograph distributions for the North and South America continents. Longitude 30° W–150° W.

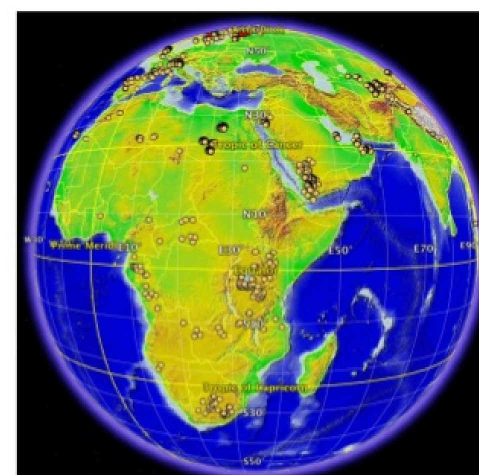


Fig. 5. Petroglyph and pictograph distributions for the African Continent and adjoining regions. Longitude 90° E–30° W.

Any particular reason why Anthony Peratt mapped no sites in [Russia, Belarus, Ukraine]?
<grin - just kidding, there are some>

Paul Anderson,US Army Research chemist, SAFIRE core team member

Electric scarring of Earth, Alberta equivalents