Lattice Energy LLC

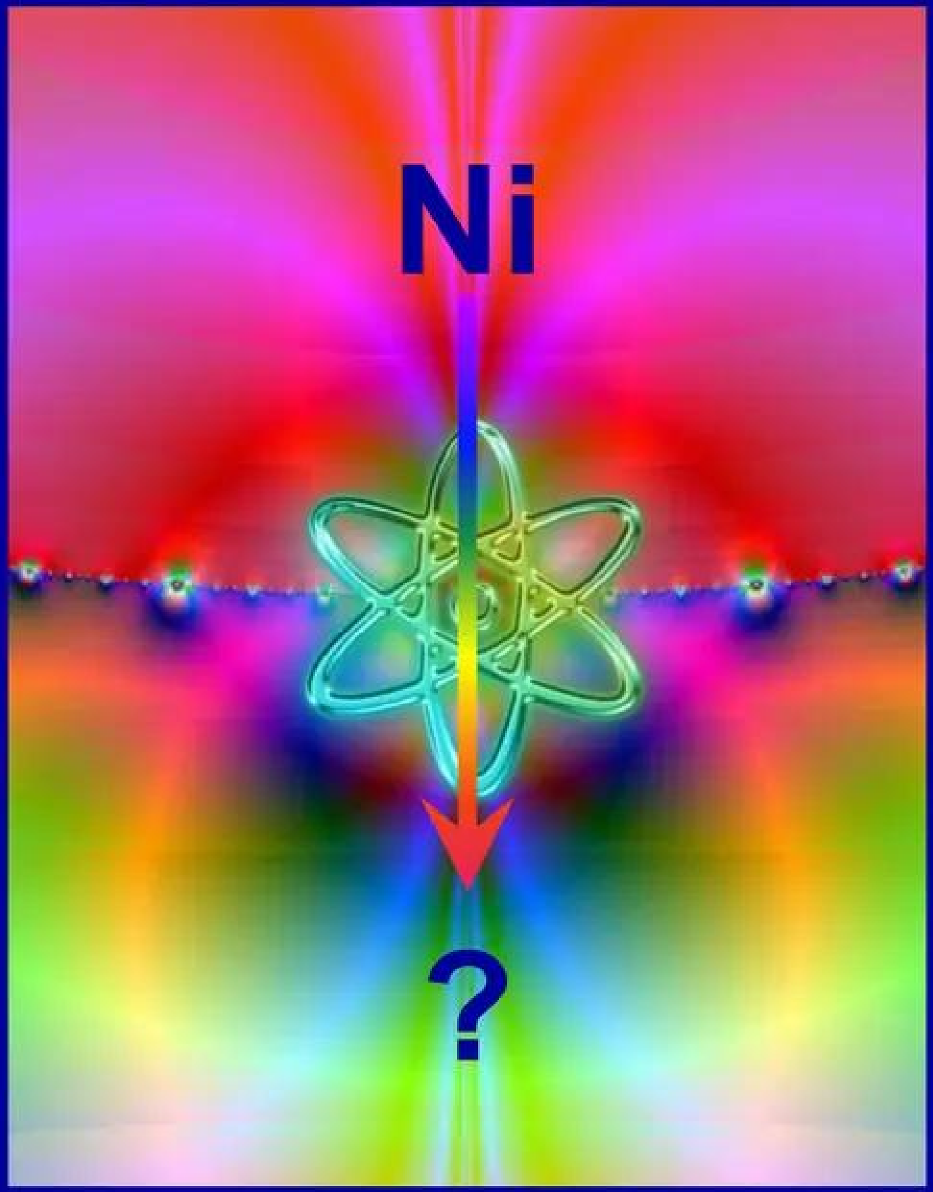
Commercializing a Next-Generation Source of Safe Nuclear Energy

Low Energy Nuclear Reactions (LENRs)

Mystery of the missing Nickel and Vanadium

Pyrolysis of crude oils in gold-lined stainless steel P/T reactors

Prosaic explanation? Or were there LENR transmutations? Experimental opportunities?



Credit: Adapted from J. Haas

Lewis G. Larsen
President and CEO

November 6, 2011

> *"There is nothing as deceptive as an obvious fact."*
>
> Sherlock Holmes
> *"The Boscombe Valley Mystery"* 1891

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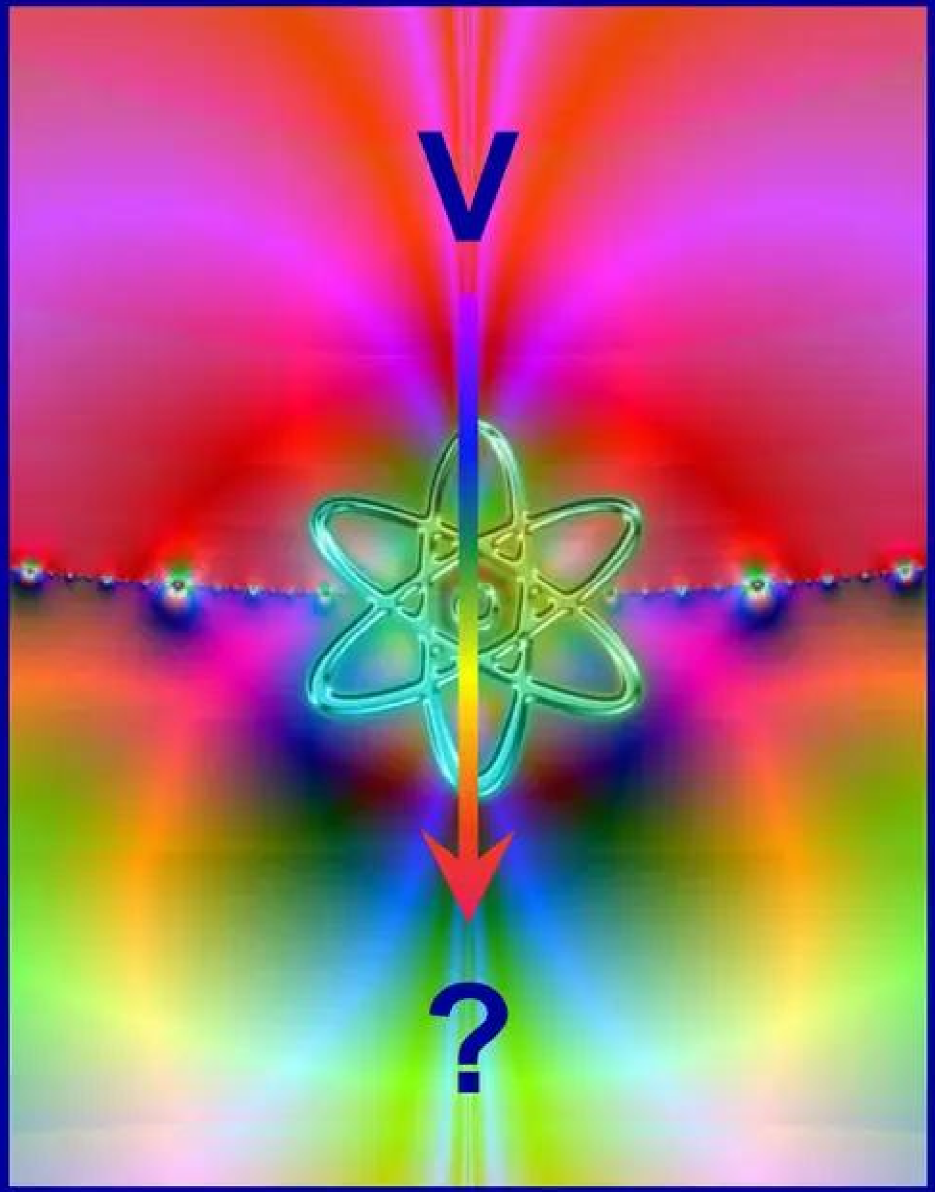

Credit: Adapted from J. Haas

Reference: What happened to the Ni and V?

Peer-reviewed journal paper (1992):

"Hydrous pyrolysis of crude oil in gold-plated reactors"

J.A. Curiale[1], P.D. Lundegard[1], Y.K. Kharaka[2]

[1]Unocal, Inc., Brea, California, U.S.A. , [2]U.S. Geological Survey, Menlo Park, California, U.S.A.

***Organic Geochemistry* 18 pp. 745 - 756 (1992) http://dx.doi.org/10.1016/0146-6380(92)90100-C**

Note: available for online purchase of USD$31.50 from ScienceDirect

Abstract- "Crude oils from Iraq and California have been pyrolyzed under hydrous conditions at 200 and 300°C for time periods up to 210 days, in gold-plated reactors. Elemental (vanadium, nickel), stable isotopic (carbon), and molecular (n- alkanes, acyclic isoprenoids, steranes, terpanes and aromatic steroid hydrocarbons) analyses were made on the original and pyrolyzed oils. Various conventional crude oil maturity parameters, including 20S/(20S +20R)-24-ethylcholestane ratios and the side-chain-length distribution of aliphatic and aromatic steroidal hydrocarbons, were measured in an effort to assess the modification of molecular maturity parameters in clay-free settings, similar to those encountered in 'clean' reservoirs."

"Concentrations of vanadium and nickel in the Iraq oil decrease significantly and the V/(V + Ni) ratio decreases slightly, with increasing pyrolysis time/temperature. Whole oil carbon isotope ratios remain fairly constant during pyrolysis, as do hopane/sterane ratios and carbon number distribution of 5ct(H),14~t(H),17~t(H),20R steranes. These latter three parameters are considered maturity-invariant."

"The ratios of short side-chain components to long side-chain components of the regular steranes [C21/(C21 + C29R)] and the triaromatic steroid hydrocarbons [C21/(C21 + C28)] vary systematically with increasing pyrolysis time, indicating that these parameters may be useful as molecular maturity parameters for crude oils in clay-free reservoir rocks. In addition, decreases in bisnorhopane/hopane ratio with increasing pyrolysis time, in a clay-free and kerogen-free environment, suggest that the distribution of these compounds is controlled by either differential thermal stabilities or preferential release from a higher-molecular weight portion of the oil."

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Other relevant references re W-L theory

Peer-reviewed papers on Widom-Larsen LENR theory (2006, 2010):

"*Ultra low momentum neutron catalyzed nuclear reactions on metallic hydride surfaces*"
A. Widom and L. Larsen
***European Physical Journal C – Particles and Fields* 46 pp. 107 (2006 – released on arXiv in May 2005)**
http://www.newenergytimes.com/v2/library/2006/2006Widom-UltraLowMomentumNeutronCatalyzed.pdf

"A primer for electroweak induced low-energy nuclear reactions"
Y. N. Srivastava, A. Widom, and L. Larsen
***Pramana – Journal of Physics* 75 (4) pp. 617 – 637 October 2010**
http://www.ias.ac.in/pramana/v75/p617/fulltext.pdf

Relevant Lattice SlideShare presentations (not peer-reviewed):

"Lattice Energy LLC - Technical Overview - Carbon Seed LENR Networks"
L. Larsen Sept 3, 2009
http://www.slideshare.net/lewisglarsen/lattice-energy-llctechnical-overviewcarbon-seed-lenr-networkssept-3-2009

"Lattice Energy LLC - Technical Overview - PAHs and LENRs"
L. Larsen November 25, 2009
http://www.slideshare.net/lewisglarsen/lattice-energy-llctechnical-overviewpahs-and-lenrsnov-25-2009

"Lattice Energy LLC-Nickel Seed W-L LENR Nucleosynthetic Network"
L. Larsen - March 24, 2011
http://www.slideshare.net/lewisglarsen/lattice-energy-llcnickel-seed-wl-lenr-nucleosynthetic-networkmarch-24-2011

"Lattice Energy LLC - Nickel-seed LENR Networks"
L. Larsen - April 20, 2011
http://www.slideshare.net/lewisglarsen/lattice-energy-llcnickelseed-lenr-networksapril-20-2011

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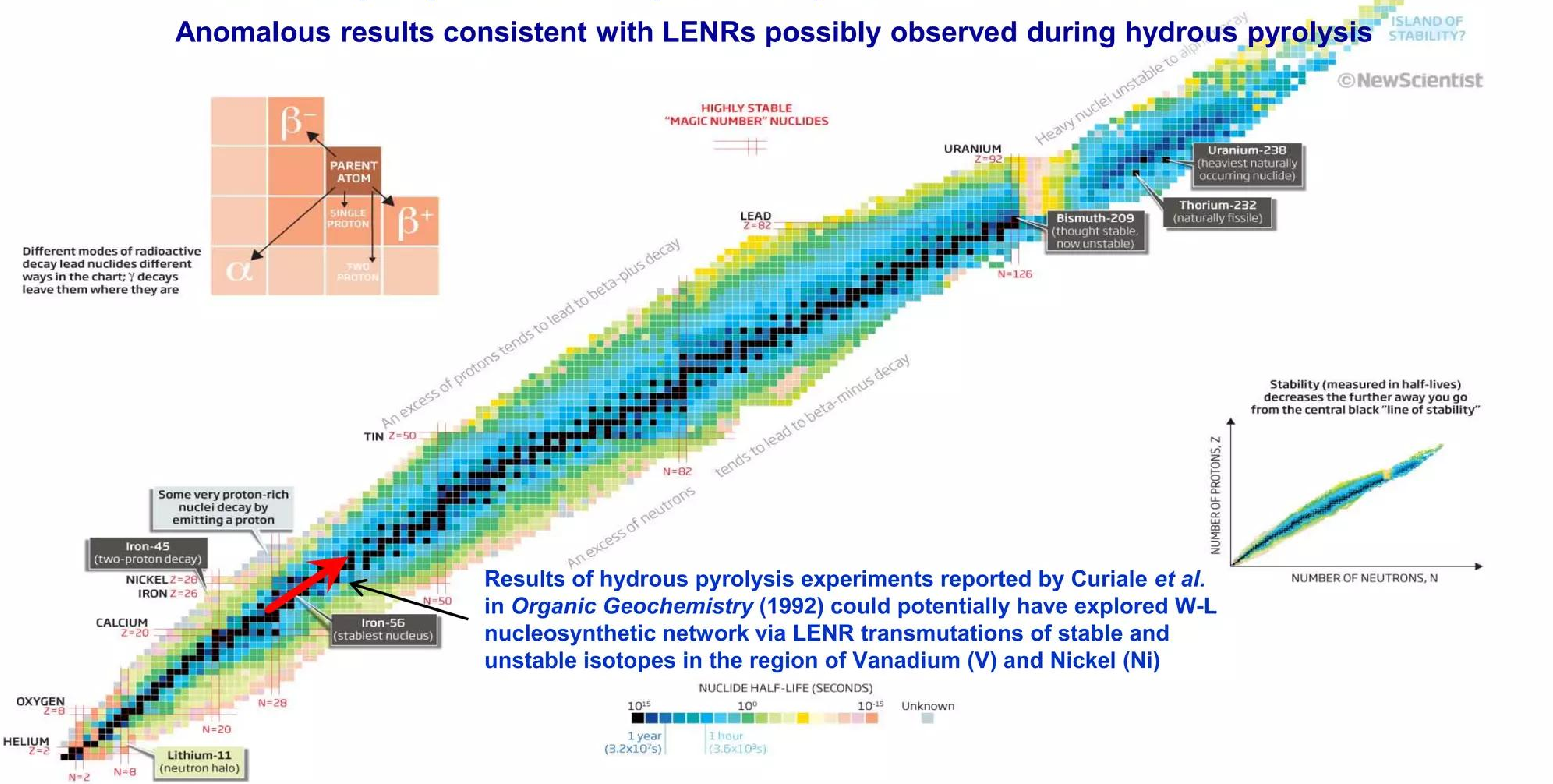
Region of LENR network explored in experiments

Vast isotopic parameter space may be accessible to W-L LENRs

Anomalous results consistent with LENRs possibly observed during hydrous pyrolysis



Results of hydrous pyrolysis experiments reported by Curiale *et al.* in *Organic Geochemistry* (1992) could potentially have explored W-L nucleosynthetic network via LENR transmutations of stable and unstable isotopes in the region of Vanadium (V) and Nickel (Ni)

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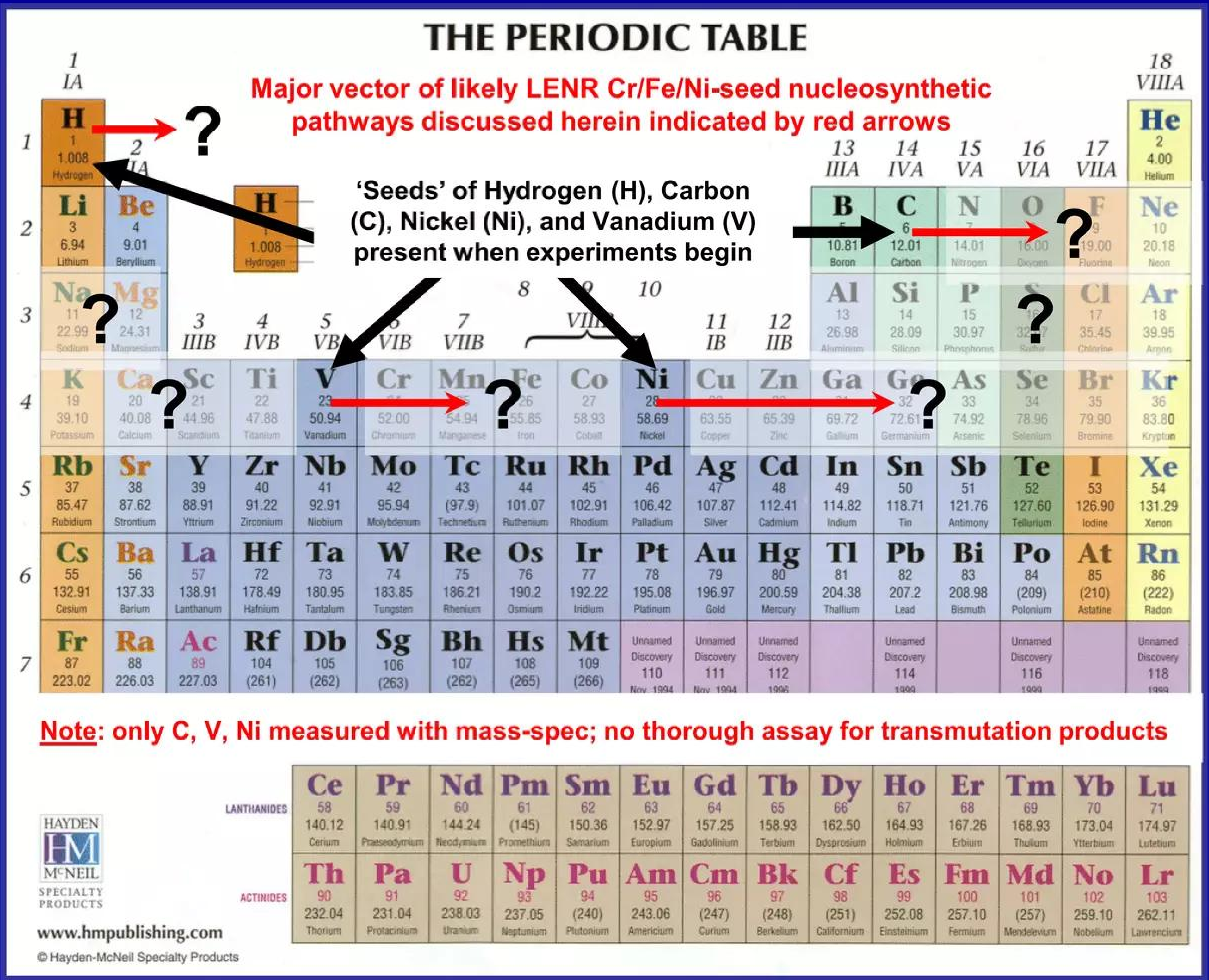
Region of LENR network explored in experiments?



THE PERIODIC TABLE

Major vector of likely LENR Cr/Fe/Ni-seed nucleosynthetic pathways discussed herein indicated by red arrows

'Seeds' of Hydrogen (H), Carbon (C), Nickel (Ni), and Vanadium (V) present when experiments begin

H 1 1.008 Hydrogen

	1 IA	2 IIA	3 IIIB	4 IVB	5 VB	6 VIB	7 VIIB	8 VIII	9	10	11 IB	12 IIB	13 IIIA	14 IVA	15 VA	16 VIA	17 VIIA	18 VIIIA
1	H 1 1.008 Hydrogen																	He 2 4.00 Helium
2	Li 3 6.94 Lithium	Be 4 9.01 Beryllium											B 5 10.81 Boron	C 6 12.01 Carbon	N 7 14.01 Nitrogen	O 16.00 Oxygen	F 9 19.00 Fluorine	Ne 10 20.18 Neon
3	Na 11 22.99 Sodium	Mg 12 24.31 Magnesium											Al 13 26.98 Aluminum	Si 14 28.09 Silicon	P 15 30.97 Phosphorus	S 16 32.07 Sulfur	Cl 17 35.45 Chlorine	Ar 18 39.95 Argon
4	K 19 39.10 Potassium	Ca 20 40.08 Calcium	Sc 21 44.96 Scandium	Ti 22 47.88 Titanium	V 23 50.94 Vanadium	Cr 24 52.00 Chromium	Mn 25 54.94 Manganese	Fe 26 55.85 Iron	Co 27 58.93 Cobalt	Ni 28 58.69 Nickel	Cu 29 63.55 Copper	Zn 30 65.39 Zinc	Ga 31 69.72 Gallium	Ge 32 72.61 Germanium	As 33 74.92 Arsenic	Se 34 78.96 Selenium	Br 35 79.90 Bromine	Kr 36 83.80 Krypton
5	Rb 37 85.47 Rubidium	Sr 38 87.62 Strontium	Y 39 88.91 Yttrium	Zr 40 91.22 Zirconium	Nb 41 92.91 Niobium	Mo 42 95.94 Molybdenum	Tc 43 (97.9) Technetium	Ru 44 101.07 Ruthenium	Rh 45 102.91 Rhodium	Pd 46 106.42 Palladium	Ag 47 107.87 Silver	Cd 48 112.41 Cadmium	In 49 114.82 Indium	Sn 50 118.71 Tin	Sb 51 121.76 Antimony	Te 52 127.60 Tellurium	I 53 126.90 Iodine	Xe 54 131.29 Xenon
6	Cs 55 132.91 Cesium	Ba 56 137.33 Barium	La 57 138.91 Lanthanum	Hf 72 178.49 Hafnium	Ta 73 180.95 Tantalum	W 74 183.85 Tungsten	Re 75 186.21 Rhenium	Os 76 190.2 Osmium	Ir 77 192.22 Iridium	Pt 78 195.08 Platinum	Au 79 196.97 Gold	Hg 80 200.59 Mercury	Tl 81 204.38 Thallium	Pb 82 207.2 Lead	Bi 83 208.98 Bismuth	Po 84 (209) Polonium	At 85 (210) Astatine	Rn 86 (222) Radon
7	Fr 87 223.02	Ra 88 226.03	Ac 89 227.03	Rf 104 (261)	Db 105 (262)	Sg 106 (263)	Bh 107 (262)	Hs 108 (265)	Mt 109 (266)	Unnamed Discovery 110 Nov 1994	Unnamed Discovery 111 Nov 1994	Unnamed Discovery 112 1996		Unnamed Discovery 114 1999		Unnamed Discovery 116 1999		Unnamed Discovery 118 1999

Note: only C, V, Ni measured with mass-spec; no thorough assay for transmutation products

LANTHANIDES	Ce 58 140.12 Cerium	Pr 59 140.91 Praseodymium	Nd 60 144.24 Neodymium	Pm 61 (145) Promethium	Sm 62 150.36 Samarium	Eu 63 152.97 Europium	Gd 64 157.25 Gadolinium	Tb 65 158.93 Terbium	Dy 66 162.50 Dysprosium	Ho 67 164.93 Holmium	Er 68 167.26 Erbium	Tm 69 168.93 Thulium	Yb 70 173.04 Ytterbium	Lu 71 174.97 Lutetium
ACTINIDES	Th 90 232.04 Thorium	Pa 91 231.04 Protacinium	U 92 238.03 Uranium	Np 93 237.05 Neptunium	Pu 94 (240) Plutonium	Am 95 243.06 Americium	Cm 96 (247) Curium	Bk 97 (248) Berkelium	Cf 98 (251) Californium	Es 99 252.08 Einsteinium	Fm 100 257.10 Fermium	Md 101 (257) Mendelevium	No 102 259.10 Nobelium	Lr 103 262.11 Lawrencium

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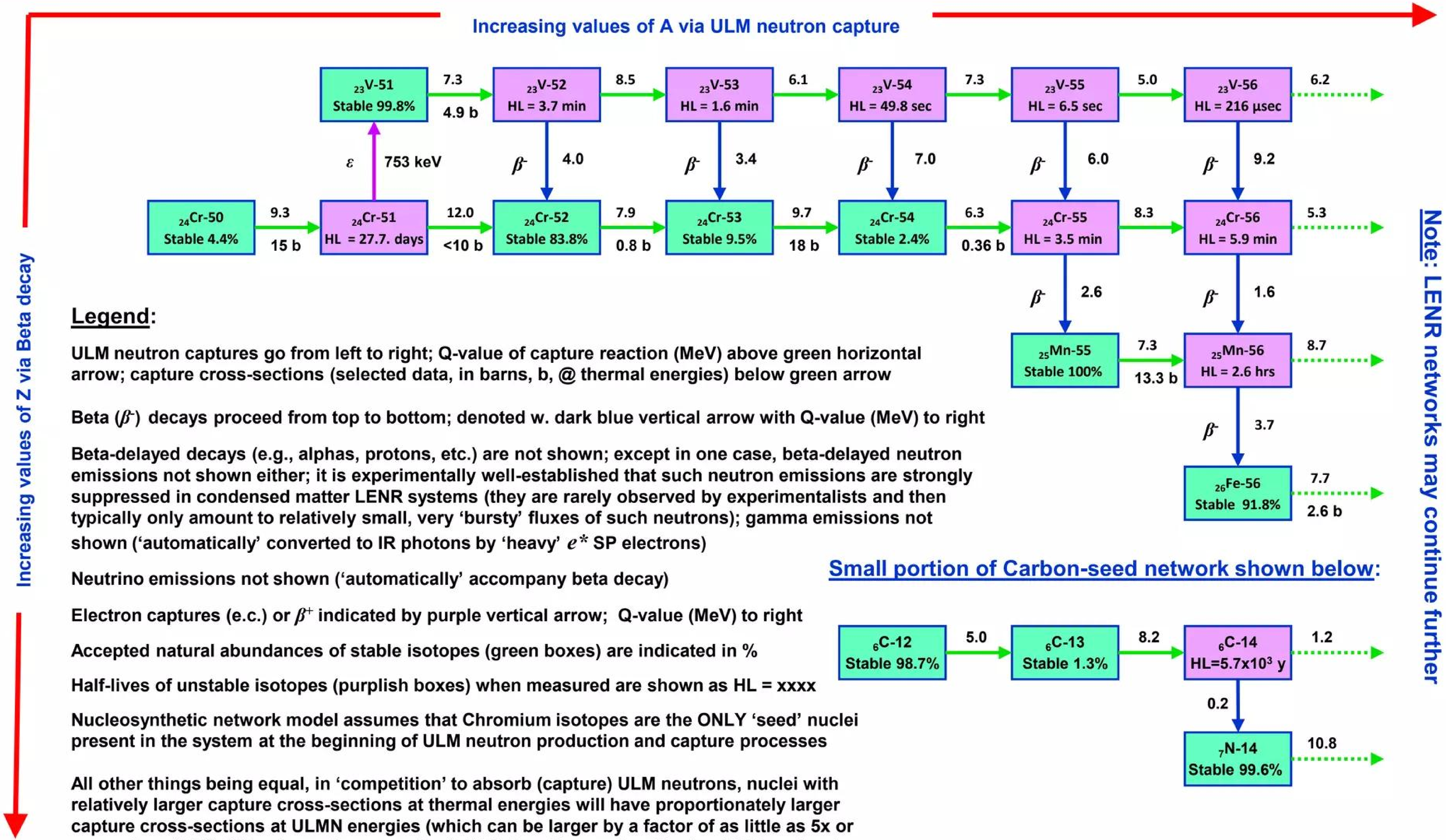
LENR transmutation network in region of V and Ni



Legend:

ULM neutron captures go from left to right; Q-value of capture reaction (MeV) above green horizontal arrow; capture cross-sections (selected data, in barns, b, @ thermal energies) below green arrow

Beta (β^-) decays proceed from top to bottom; denoted w. dark blue vertical arrow with Q-value (MeV) to right

Beta-delayed decays (e.g., alphas, protons, etc.) are not shown; except in one case, beta-delayed neutron emissions not shown either; it is experimentally well-established that such neutron emissions are strongly suppressed in condensed matter LENR systems (they are rarely observed by experimentalists and then typically only amount to relatively small, very 'bursty' fluxes of such neutrons); gamma emissions not shown ('automatically' converted to IR photons by 'heavy' e^* SP electrons)

Neutrino emissions not shown ('automatically' accompany beta decay)

Electron captures (e.c.) or β^+ indicated by purple vertical arrow; Q-value (MeV) to right

Accepted natural abundances of stable isotopes (green boxes) are indicated in %

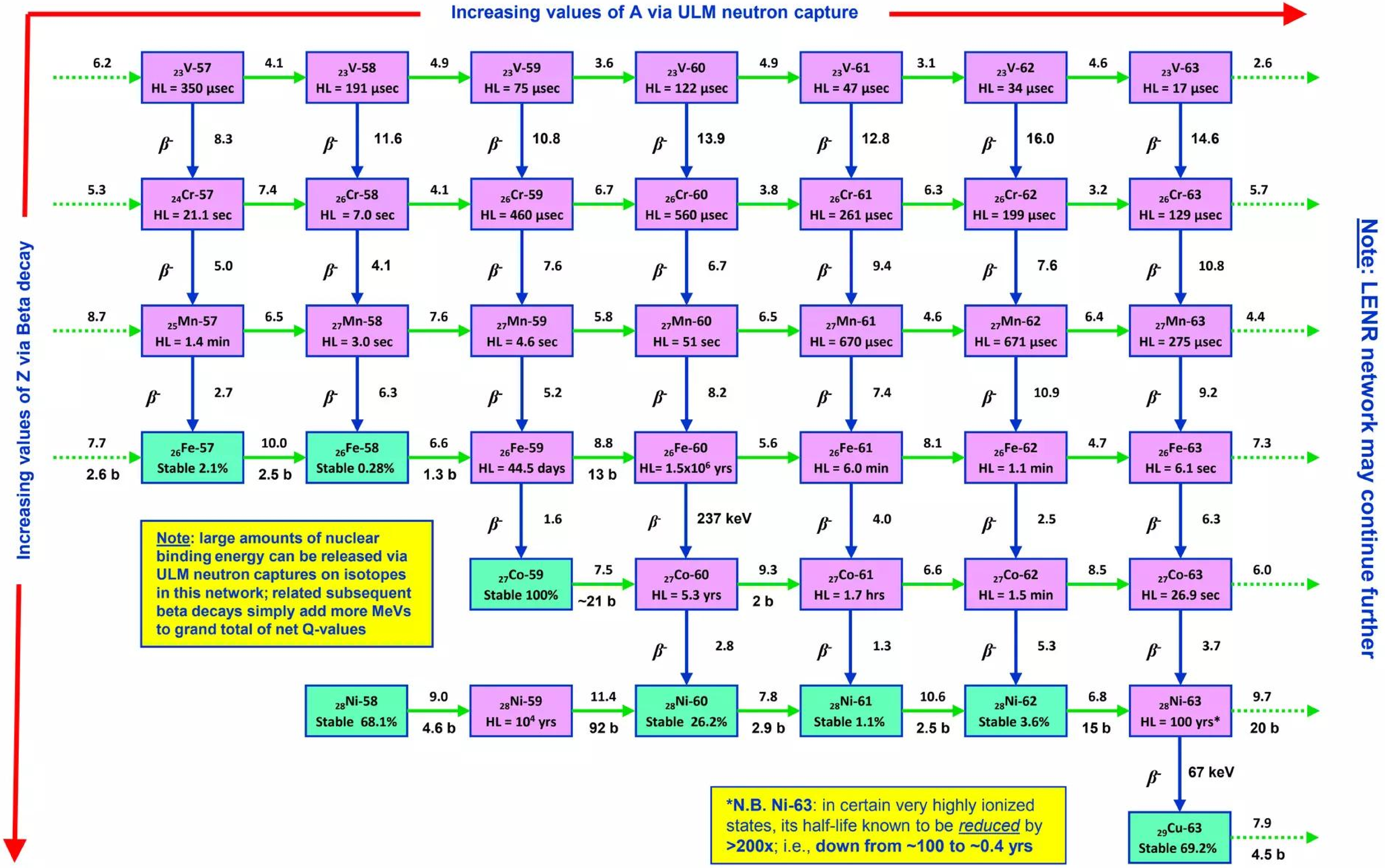
Half-lives of unstable isotopes (purplish boxes) when measured are shown as HL = xxxx

Nucleosynthetic network model assumes that Chromium isotopes are the ONLY 'seed' nuclei present in the system at the beginning of ULM neutron production and capture processes

All other things being equal, in 'competition' to absorb (capture) ULM neutrons, nuclei with relatively larger capture cross-sections at thermal energies will have proportionately larger capture cross-sections at ULMN energies (which can be larger by a factor of as little as 5x or as much as 1,000,000x, depending upon the Q-M DeBroglie wavelength of an ULM neutron)

Small portion of Carbon-seed network shown below:

Note: LENR networks may continue further



Increasing values of A via ULM neutron capture

Increasing values of Z via Beta decay

Note: LENR network may continue further

6.2 → $_{23}$V-57 HL = 350 µsec → 4.1 → $_{23}$V-58 HL = 191 µsec → 4.9 → $_{23}$V-59 HL = 75 µsec → 3.6 → $_{23}$V-60 HL = 122 µsec → 4.9 → $_{23}$V-61 HL = 47 µsec → 3.1 → $_{23}$V-62 HL = 34 µsec → 4.6 → $_{23}$V-63 HL = 17 µsec → 2.6

β^- 8.3; β^- 11.6; β^- 10.8; β^- 13.9; β^- 12.8; β^- 16.0; β^- 14.6

5.3 → $_{24}$Cr-57 HL = 21.1 sec → 7.4 → $_{26}$Cr-58 HL = 7.0 sec → 4.1 → $_{26}$Cr-59 HL = 460 µsec → 6.7 → $_{26}$Cr-60 HL = 560 µsec → 3.8 → $_{26}$Cr-61 HL = 261 µsec → 6.3 → $_{26}$Cr-62 HL = 199 µsec → 3.2 → $_{26}$Cr-63 HL = 129 µsec → 5.7

β^- 5.0; β^- 4.1; β^- 7.6; β^- 6.7; β^- 9.4; β^- 7.6; β^- 10.8

8.7 → $_{25}$Mn-57 HL = 1.4 min → 6.5 → $_{27}$Mn-58 HL = 3.0 sec → 7.6 → $_{27}$Mn-59 HL = 4.6 sec → 5.8 → $_{27}$Mn-60 HL = 51 sec → 6.5 → $_{27}$Mn-61 HL = 670 µsec → 4.6 → $_{27}$Mn-62 HL = 671 µsec → 6.4 → $_{27}$Mn-63 HL = 275 µsec → 4.4

β^- 2.7; β^- 6.3; β^- 5.2; β^- 8.2; β^- 7.4; β^- 10.9; β^- 9.2

7.7 2.6 b → $_{26}$Fe-57 Stable 2.1% → 10.0 2.5 b → $_{26}$Fe-58 Stable 0.28% → 6.6 1.3 b → $_{26}$Fe-59 HL = 44.5 days → 8.8 13 b → $_{26}$Fe-60 HL= 1.5x10^6 yrs → 5.6 → $_{26}$Fe-61 HL = 6.0 min → 8.1 → $_{26}$Fe-62 HL = 1.1 min → 4.7 → $_{26}$Fe-63 HL = 6.1 sec → 7.3

β^- 1.6; β^- 237 keV; β^- 4.0; β^- 2.5; β^- 6.3

$_{27}$Co-59 Stable 100% → 7.5 ~21 b → $_{27}$Co-60 HL = 5.3 yrs → 9.3 2 b → $_{27}$Co-61 HL = 1.7 hrs → 6.6 → $_{27}$Co-62 HL = 1.5 min → 8.5 → $_{27}$Co-63 HL = 26.9 sec → 6.0

β^- 2.8; β^- 1.3; β^- 5.3; β^- 3.7

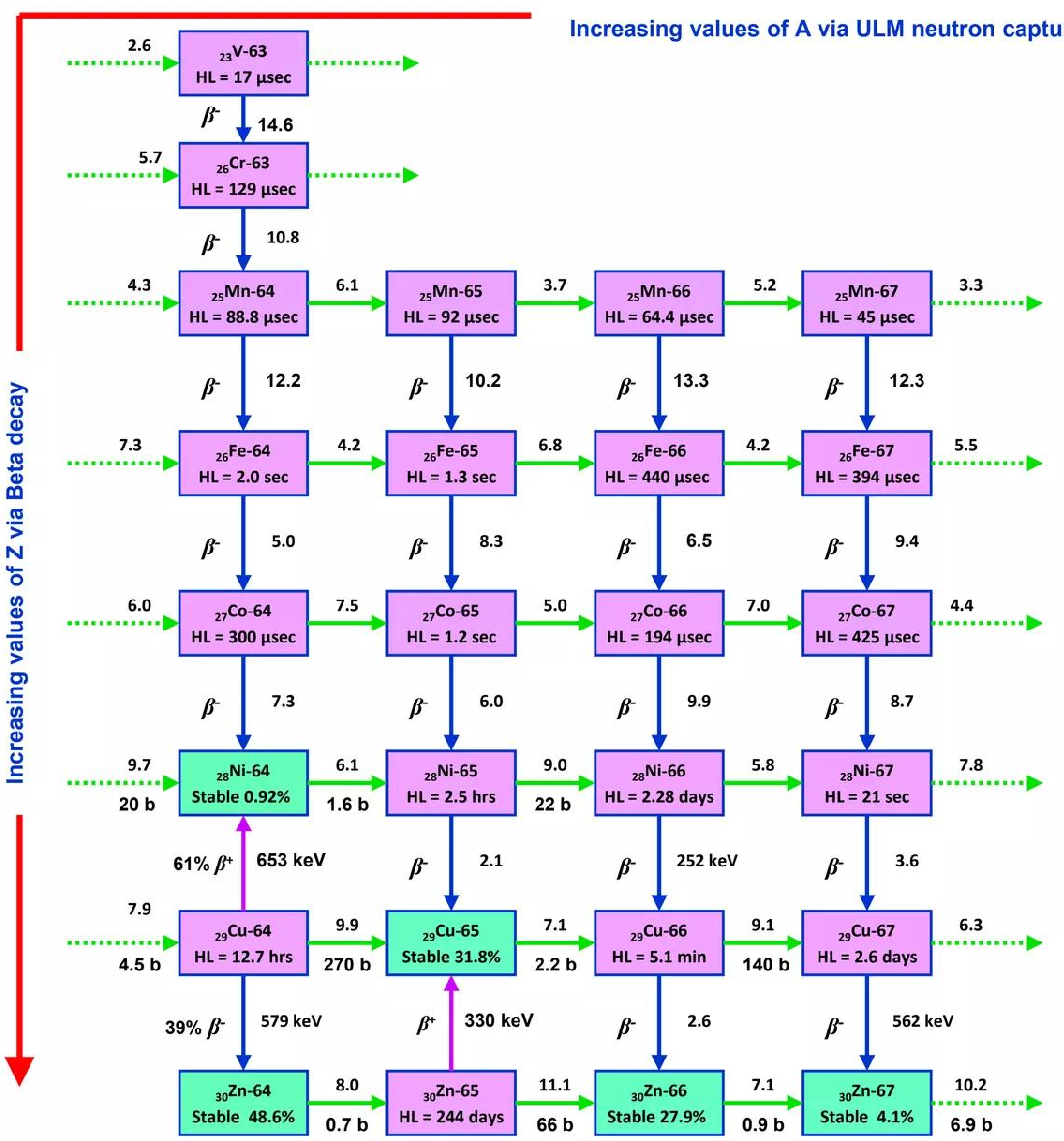
$_{28}$Ni-58 Stable 68.1% → 9.0 4.6 b → $_{28}$Ni-59 HL = 10^4 yrs → 11.4 92 b → $_{28}$Ni-60 Stable 26.2% → 7.8 2.9 b → $_{28}$Ni-61 Stable 1.1% → 10.6 2.5 b → $_{28}$Ni-62 Stable 3.6% → 6.8 15 b → $_{28}$Ni-63 HL = 100 yrs* → 9.7 20 b

β^- 67 keV

$_{29}$Cu-63 Stable 69.2% → 7.9 4.5 b

Note: large amounts of nuclear binding energy can be released via ULM neutron captures on isotopes in this network; related subsequent beta decays simply add more MeVs to grand total of net Q-values

***N.B. Ni-63**: in certain very highly ionized states, its half-life known to be *reduced* by **>200x**; i.e., **down from ~100 to ~0.4 yrs**



<u>Note</u>: LENR nuclear transmutation network may continue even further with larger, longer-duration neutron fluxes

ULM neutron-catalyzed LENR networks occur in *nm*- to *μ*-scale nuclear-active 'patches' that form spontaneously on surfaces

LENR networks are very dynamic entities: over time they appear, run for a short while (e.g., 200 – 300 *nanoseconds*) while producing/capturing neutrons, making unstable/stable products, and then 'die'

During long duration energy inputs, given micron-scale surface location may have had none, one, or many local episodes of nucleosynthesis occurring on them. In case of multiple episodes, each in turn picks-up' where the previously existing LENR network left-off, with the transmutation products of prior networks then serving as input 'target seeds' for the next generation of nuclear reactions. They are thus 'born' and 'reborn'

At end of an experiment or period of energy input, depending on the size/duration of ULM neutron fluxes and specifics of prior local nucleosynthetic 'seeds,' an LENR-active surface may have substantial microscopic variations in final stable products scattered very randomly across its entire expanse

Myriad of different *nanometer*- to *micron*-scale electromagnetic effects, LENR nuclear processes, and prosaic chemical reactions all occur simultaneously and *in parallel* on LENR-active surfaces; some regions may be absorbing and transporting E-M energy locally, while others nearby can be emitting energy (e.g., as energetic electrons, photons, other charged particles, etc.) – <u>very complex</u>

Main objectives of presentation

Discuss anomalies observed in crude oil pyrolysis experiments

Pyrolysis (selected excerpts quoted from Wikipedia):

- Thermochemical decomposition of organic material at elevated temperatures without the participation of [gaseous] oxygen. It involves the simultaneous change of chemical composition and physical phase, and is irreversible. Pyrolysis is a special case of thermolysis, and is most commonly used for organic materials, being, therefore, one of the processes involved in charring. The pyrolysis of wood, which starts at 200 - 300 °C (390 - 570 °F), occurs for example in fires where solid fuels are burning or when vegetation comes into contact with lava in volcanic eruptions. In general, pyrolysis of organic substances produces gas and liquid products and leaves a solid residue richer in carbon content, char. Extreme pyrolysis, which leaves mostly carbon as the residue, is called carbonization.

- Used heavily in the chemical industry, for example, to produce charcoal, activated carbon, methanol, and other chemicals from wood, to convert ethylene dichloride into vinyl chloride to make PVC, to produce coke from coal, to convert biomass into syngas and biochar, to turn waste into safely disposable substances, and for transforming medium-weight hydrocarbons from oil into lighter ones like gasoline. These specialized uses of pyrolysis may be called various names, such as dry distillation, destructive distillation, or cracking.

- Pyrolysis differs from other high-temperature processes like combustion and hydrolysis in that it does not involve reactions with oxygen, water, or any other reagents. In practice, it is not possible to achieve a completely oxygen-free atmosphere. Because some oxygen is present in any pyrolysis system, a small amount of oxidation occurs.

- Hydrous pyrolysis refers to the thermal decomposition which takes place when organic compounds are heated to high temperatures in the presence of water. Steam cracking is used in the petroleum industry to produce the lighter alkenes. Steam cracking uses water in the gas phase, whereas many hydrous pyrolysis processes use superheated water in the liquid phase. Hydrous pyrolysis may be a significant process in the creation of fossil fuels. Simple heating without water, anhydrous pyrolysis has long been considered to take place naturally during the catagenesis of kerogens to fossil fuels. In recent decades it has been found that water under pressure causes more efficient breakdown of kerogens at lower temperatures than without it.

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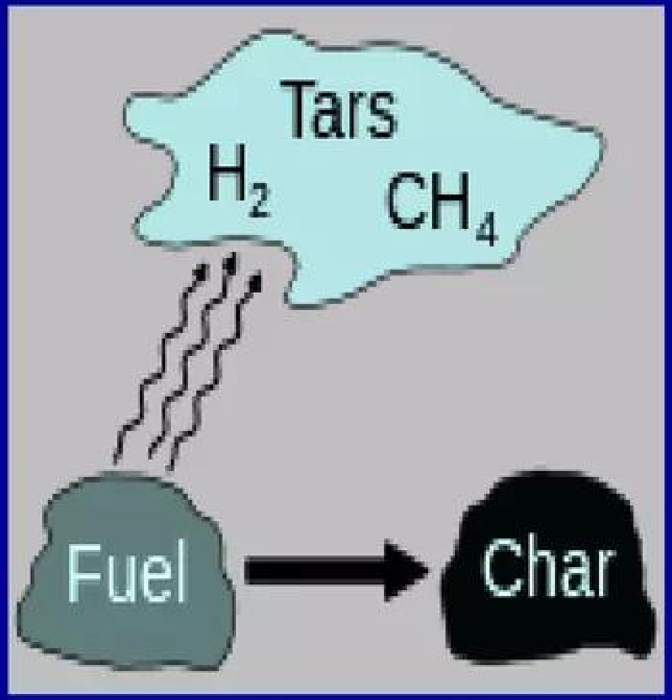
History of thermal processing in the oil industry

Began in 1862 - hydrocracking started to be utilized in 1960s



Basic pyrolysis - Credit: Wikipedia

Modern oil hydrocracking unit

Year	Process name	Process purpose	Process by-products
1862	Atmospheric distillation	Produce kerosene	Naphtha, tar, etc.
1870	Vacuum distillation	Lubricants (original) Cracking feedstocks (1930s)	Asphalt, residual Coker feedstocks
1913	Thermal cracking	Increase gasoline	Residual, bunker fuel
1916	Sweetening	Reduce sulphur and odour	Sulphur
1930	Thermal reforming	Improve octane number	Residual
1932	Hydrogenation	Remove sulphur	Sulphur
1932	Coking	Produce gasoline base stocks	Coke
1933	Solvent extraction	Improve lubricant viscosity index	Aromatics
1935	Solvent dewaxing	Improve pour point	Waxes
1935	Catalytic polymerization	Improve gasoline yield and octane number	Petrochemical feedstocks
1937	Catalytic cracking	Higher octane gasoline	Petrochemical feedstocks
1939	Visbreaking	Reduce viscosity	Increased distillate, tar
1940	Alkylation	Increase gasoline octane and yield	High-octane aviation gasoline
1940	Isomerization	Produce alkylation feedstock	Naphtha
1942	Fluid catalytic cracking	Increase gasoline yield and octane	Petrochemical feedstocks
1950	Deasphalting	Increase cracking feedstock	Asphalt
1952	Catalytic reforming	Convert low-quality naphtha	Aromatics
1954	Hydrodesulphurization	Remove sulphur	Sulphur
1956	Inhibitor sweetening	Remove mercaptan	Disulphides
1957	Catalytic isomerization	Convert to molecules with high octane number	Alkylation feedstocks
1960	**Hydrocracking**	**Improve quality and reduce sulphur**	**Alkylation feedstocks**
1974	Catalytic dewaxing	Improve pour point	Wax
1975	**Residual hydrocracking**	**Increase gasoline yield from residual**	**Heavy residuals**

Data source Richard S. Kraus

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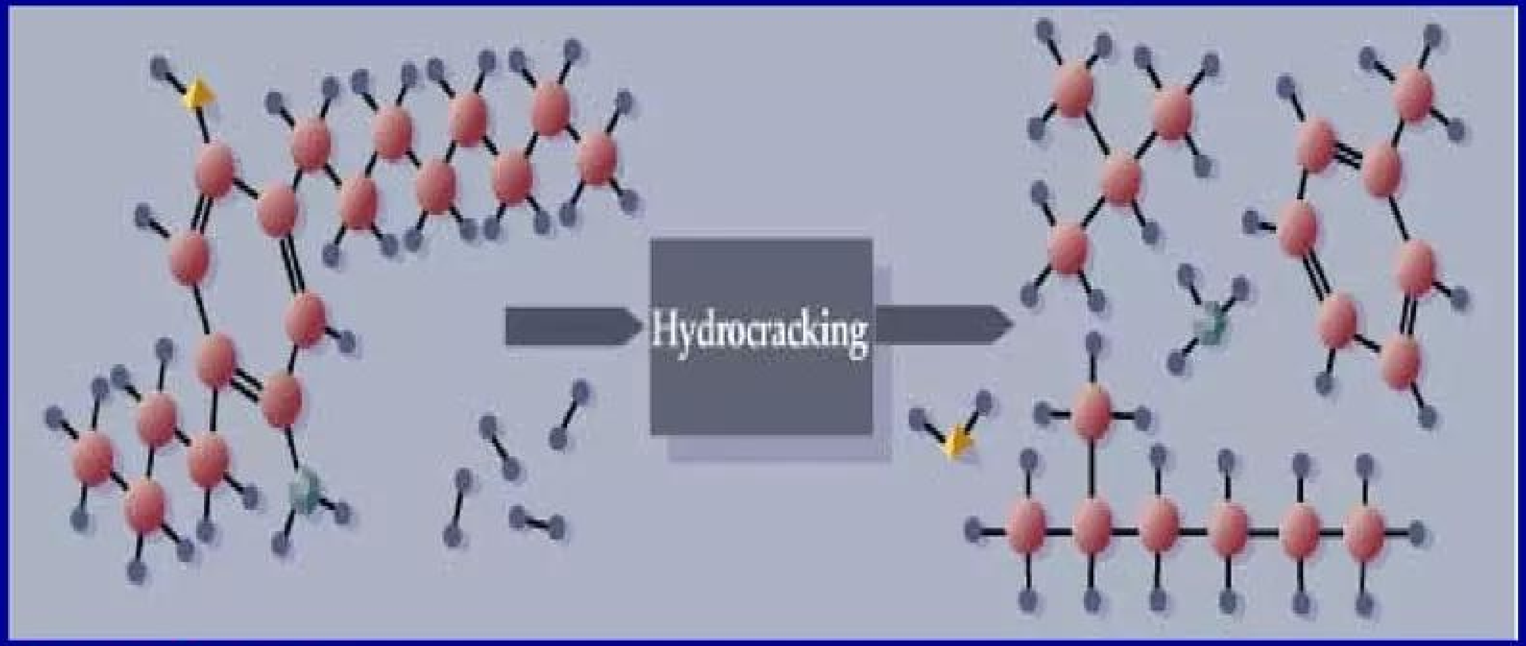
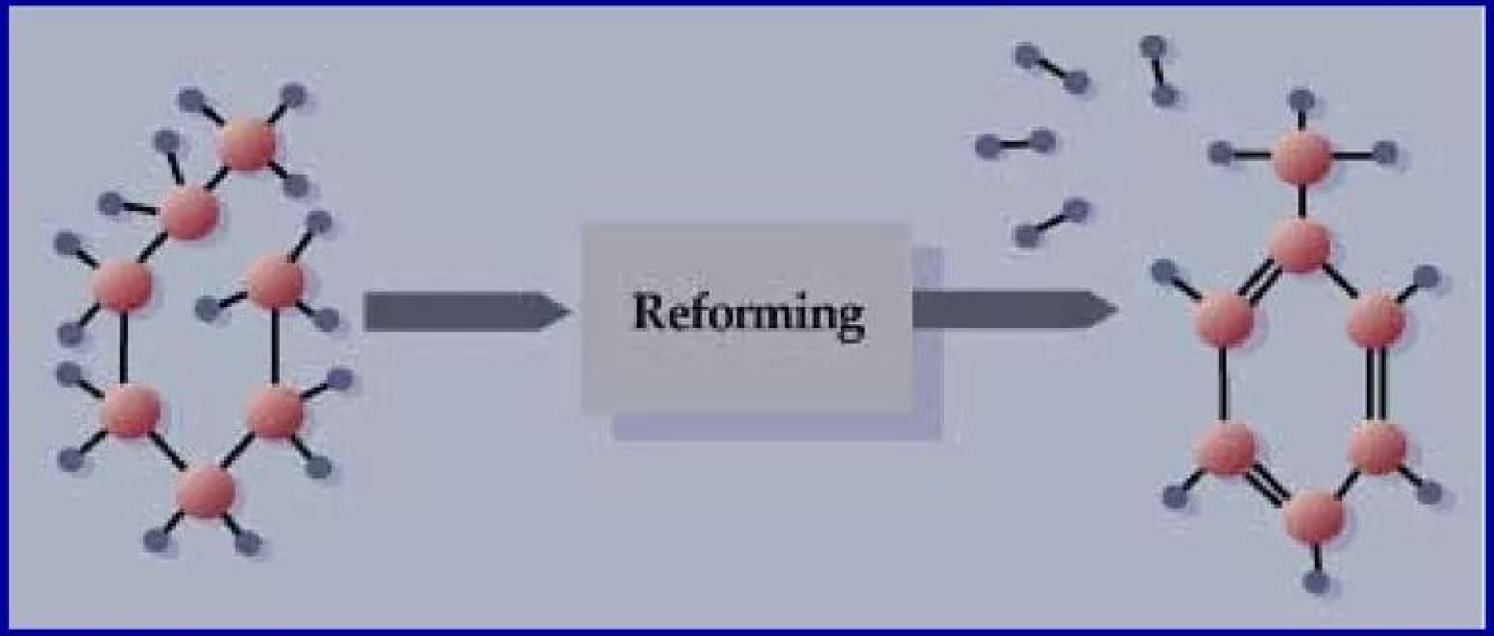
Molecular modification via thermal processing

Chemical reactions may occur with/without any metallic catalysts



Credit: Chevron



Credit: Chevron

Catalytic reforming **(source Wikipedia):**

Chemical process used to convert petroleum refinery naphthas, typically having low octane ratings, into high-octane liquid products called reformates which are components of high-octane gasoline (also known as petrol). Basically, the process re-arranges or re-structures the hydrocarbon molecules in the naphtha feedstocks as well as breaking some of the molecules into smaller molecules. The overall effect is that the product reformate contains hydrocarbons with more complex molecular shapes having higher octane values than the hydrocarbons in the naphtha feedstock. In so doing, the process separates hydrogen atoms from the hydrocarbon molecules and produces very significant amounts of byproduct hydrogen gas for use in a number of the other processes involved in a modern petroleum refinery. Other byproducts are small amounts of methane, ethane, propane, and butanes.

Process is quite different from and not to be confused with the catalytic steam reforming process used industrially to produce various products such as hydrogen, ammonia, and methanol from natural gas, naphtha or other petroleum-derived feedstocks. Nor is this process to be confused with various other catalytic reforming processes that use methanol or biomass-derived feedstocks to produce hydrogen for fuel cells or other uses.

There are many chemical reactions that occur in the catalytic reforming process, all of which occur in the presence of a catalyst and a high partial pressure of hydrogen. Depending upon the type or version of catalytic reforming used as well as the desired reaction severity, the reaction conditions range from temperatures of about 495 to 525 °C and from pressures of about 5 to 45 atm. The commonly used catalytic reforming catalysts contain noble metals such as platinum and/or rhenium, which are very susceptible to poisoning by sulfur and nitrogen compounds. Therefore, the naphtha feedstock to a catalytic reformer is always pre-processed in a hydrodesulfurization unit which removes both the sulfur and the nitrogen compounds.

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Example of modern thermal processing

The Chevron Pascagoula Refinery's refining process begins when crude oil is distilled in two large Crude Units that have three distillation columns, one that operates at near atmospheric pressure, and two others that operate at less than atmospheric pressure, i.e., a vacuum.

During this process, the lightest materials, like propane and butane, vaporize and rise to the top of the first atmospheric column.

Medium weight materials, including gasoline, jet and diesel fuels, condense in the middle.

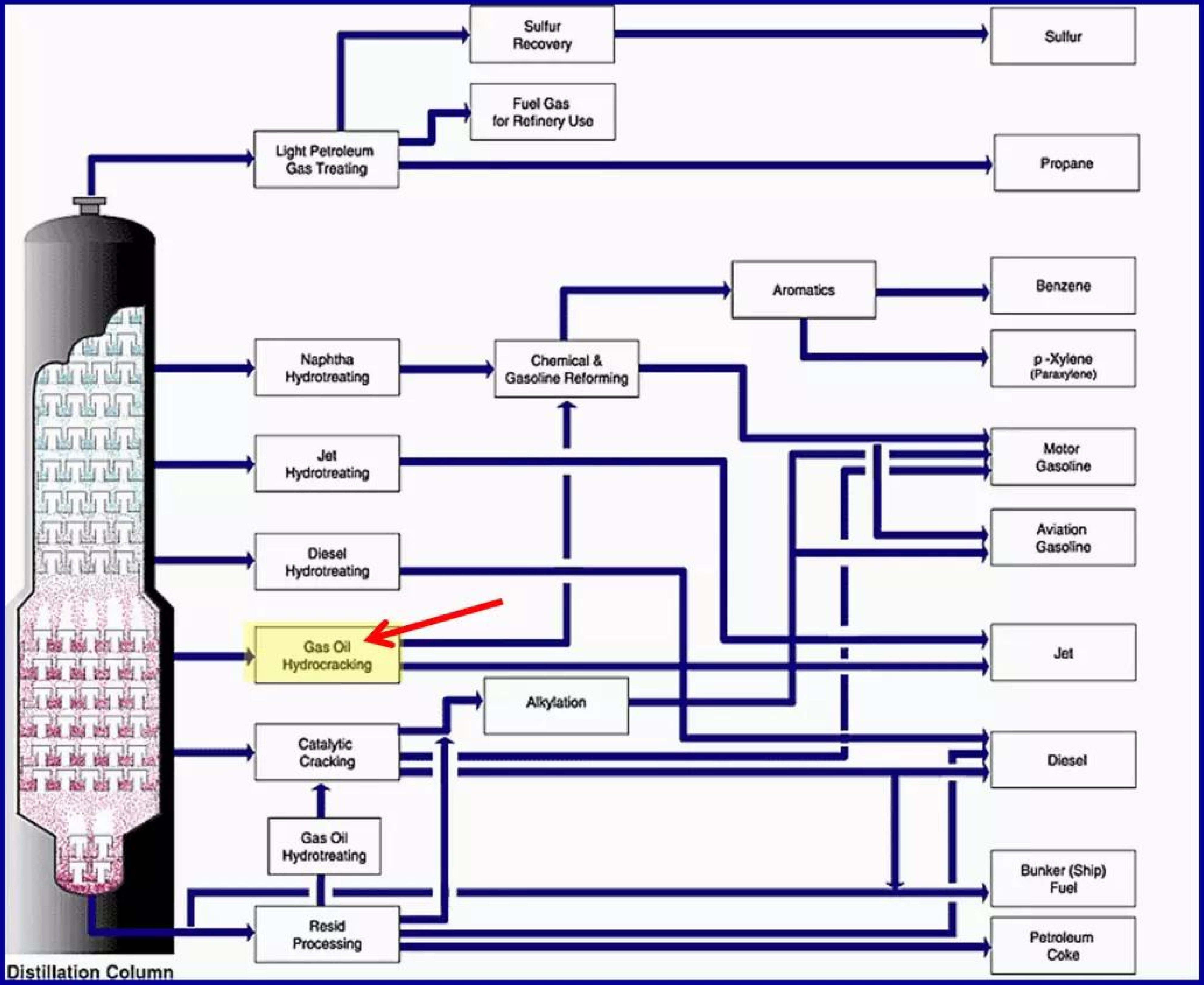
Heavy materials, called gas oils, condense in the lower portion of the atmospheric column.

The heaviest tar-like material, called residuum, is referred to as the "bottom of the barrel" because it never really rises.

This distillation process is repeated in many other plants as the oil is further refined to make various products.

Quote: Chevron

Chevron Pascagoula Refinery



Credit: Chevron

Heat & catalysts are used to convert the heavier oils to lighter products using three "cracking" methods: fluid catalytic cracking (FCC), hydrocracking (Isomax), and coking (or thermal-cracking).

Fluid Catalytic Cracker (FCC) uses high temperature and catalyst to crack 86,000 barrels (3.6 million gallons) each day of heavy gas oil mostly into gasoline.

Hydrocracking uses catalysts to react gas oil and hydrogen under high pressure and high temperature to make both jet fuel and gasoline --- about 58,000 barrels (2.4 million gallons) of lighter gas oil is converted daily in two Isomax Units, using this hydrocracking process.

Gasoline process streams in refinery that have low octane rating sent to Reforming Unit where octane levels are boosted --- these employ precious-metal catalysts - platinum and rhenium – and thus called "rheniformers." In this process, hydrocarbon molecules are "reformed" into high octane gasoline components. For example, methyl cyclohexane is reformed into toluene.

Quote: Chevron

Main objectives of presentation

Discuss anomalies observed in crude oil pyrolysis experiments

Likely LENR transmutation products associated with pyrolysis-like physical processes (high temps/pressures and metals present in ~absence of O_2 gas) **have been observed**, publicly reported, and published by various researchers, e.g. please see:

- ✓ **Mizuno** ^{13}C - 2008 (ref. Lattice SlideShare Nov. 25, 2009)
- ✓ **IAEA** ^{15}N isotope anomaly in coking ovens - 2002 (*ibid.*)
- ✓ **SRI** ^{4}He anomaly in Pd/C/D_2 - 1999 (SlideShare Sep. 3, 2009)

Using a mass spectrometer, Curiale *et al.* unequivocally measured C, Ni, and V that were all initially present in samples of crude oil from California and Iraq at the beginning of their hydrous pyrolysis experiments. Two odd effects observed at end of their experiments:

- ✓ **Carbon analyzed became somewhat isotopically heavier** (i.e., more neutron-rich relative to unpyrolyzed samples of crude oil)
- ✓ **Concentrations of Nickel and Vanadium in some crude oil samples <u>declined</u> significantly during pyrolysis.** At first simply *assumed* V and Ni *must have* 'disappeared' from oil liquid into a solid-phase fraction formed in reactors --- however, they did not observe any such solid fractions. *So where did these metals go?*
- ✓ **Left mystery of disappearing metals as big unexplained anomaly**

"No phenomenon is a real phenomenon until it is an observed phenomenon."
Prof. John Wheeler, Princeton theoretical physicist, coined the term "*black hole*" back in 1967

"If you haven't found something strange during the day, it hasn't been much of a day." ibid.

"In any field, find the strangest thing and then explore it." ibid.

"It is a capital mistake to theorize before one has data. Insensibly one begins to twist facts to suit theories, instead of theories to suit facts."
Sherlock Holmes, *"A Scandal in Bohemia"* 1891

Discussion: Curiale *et al.*, *Organic Geochemistry* (1992)

Description of experiments 1: pyrolyze two crude oils w. liquid water - 1

For readers' convenience, we will quote selected text directly from their paper and comment thereon

> **"In the present study, we have pyrolyzed two crude oils at 200 or 300°C in the presence of liquid water in gold-plated reactors, for periods of time up to 210 days, in an effort to understand the effects of thermal alteration on biological markers (steranes and hopanes), carbon isotope ratios and transition metal (vanadium and nickel) distributions (Curiale *et al.,* 1991). Our goal is to examine, in an oil/water, clay-free setting, the maturity-dependence and maturity-invariance of particular geochemical parameters used to evaluate source rock maturity and assess oil-source rock correlation possibilities."**

> **"Many workers have conducted clay-free experiments monitoring maturity increases in source rocks (Tannenbaum and Kaplan, 1985; Tannenbaum *et al.,* 1986) and oils (Orr, 1986; Bjoroy *et al.,* 1988; Chung et al., 1988, 1991). The elimination of clay from the reaction vessel is straightforward. However, because a reactor must be used in thermal alteration experiments, the total elimination of catalytic influence is impossible. Various workers have cited problems with contamination, and have presumed that inorganic catalysis occurs during experiments in which sample material comes in contact with stainless steel. Nickel in 316 stainless steel commonly forms tiny nickel sulfide crystals (Ni_3S_2) on the interior surface of the reaction vessel (Monin and Audibert, 1985); presumably, finely-disseminated foreign nickel-containing compounds may then become incorporated in sample material. We have observed the formation of silver and iron sulfides during hydrous pyrolysis of petroleum source rocks in stainless steel reaction vessels (G. P. OueUette and J. A. Curiale, unpublished results). Gold reactors were recently employed to minimize such problems (Kressmann *et al., 1989).*"**

Lattice Energy LLC

Discussion: Curiale *et al*., *Organic Geochemistry* (1992)

Description of experiments 2: type 316 SS reactor walls plated w. Gold

For readers' convenience, we will quote selected text directly from their paper and comment thereon

"The use of gold surfaces minimizes problems associated with stainless steel catalytic effects, including the effect of organic acid destruction (Palmer and Drummond, 1986; Lundegard and Senftle, 1987; Kharaka and Lundegard, in prep.). Our use of reactors whose interiors are entirely gold or gold-plated provided us with reasonable certainty that reactor-induced inorganic catalysis was absent. No inorganic solids were observed to form within the reaction vessel during the experiments described here."

Lattice comments - there are three key points here: (1) all metal surfaces on the interior of the Type 316 stainless steel reactor that could conceivably ever come in contact with heated liquids being pyrolyzed were either plated with Gold (Au), or solid Gold (sampling ports and tubes); (2) while metallic Gold may well be more-or-less inert with respect to prosaic chemical catalysis of petroleum fluids, Gold is definitely not inert with respect to potentially supporting LENRs on such Au surfaces; Au and Silver (Ag) happen to be elements in which it is extremely easy to excite surface plasmon electrons ($e_{sp} + p \rightarrow n_{ulm} + \nu$) naturally found on metal surfaces; and the (3) fact that "... no organic solids were observed to form within the reaction vessel during the experiments ..." is very important with regard to mystery about 'missing' Ni and V

Absence of solids formation is a crucial point because only liquids are sampled to undergo mass spectroscopy that analyzes Carbon isotopes, Ni, and V --- solid residues of any kind are not analyzed. In prior work where trace metals had apparently 'disappeared', researchers just assumed that they had been incorporated in un-analyzed solids (which had formed therein)

Lattice Energy LLC

Discussion: Curiale *et al*., *Organic Geochemistry* (1992)

Description of experiments 3: details - oil samples and procedures

For readers' convenience, we will quote selected text directly from their paper and comment thereon

- ✓ **"We subjected oils to hydrous pyrolysis using one liter gold-plated reactors. All interior parts of the reactor were gold-plated over 316 stainless steel. Iraq (Kirkuk Field) and California (Midway-Sunset Field, San Joaquin Basin) oils were pyrolyzed."**
- ✓ **"Iraq sample is a paraffinic oil having a sulfur content of 1.5 wt %, a pristane/phytane ratio of approximately 1.0, and no n-alkane carbon chain length preference. It exhibits no obvious signs of biodegradation. California oil contains high relative concentrations of tetra- and pentacyclic hydrocarbons, and has virtually no n-alkanes or isoprenoids (both lost due to extensive biodegradation). Its sulfur concentration is 0.8wt %."**
- ✓ **"In the 300°C experiments, 215 g of double-distilled, deionized water and either 195.6 g (Iraq) or 214.6 g (California) of oil were pyrolyzed in the gold-plated reactor. For the 200°C experiment, 214.2 g of water and 205.9 g of California oil were used."**
- ✓ **"Reactor configuration and rotation apparatus are similar to those described by Seyfried *et al.* (1979, 1987), except that one-liter gold-plated reactors were used instead of gold-foil bags, and a dual sampling tube arrangement was employed. The reactor was purged with argon prior to sealing, and the oil/water mixture was pyrolyzed under a helium atmosphere at 200 or 300°C for various lengths of time. During the experiments, the reactors were continuously rotated through a 180 degree arc (as described in Seyfried *et al*., 1979) to maintain a homogenous mixture."**

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Discussion: Curiale *et al.*, *Organic Geochemistry* (1992)

Description of experiments 4: details - procedures and sampling

For readers' convenience, we will quote selected text directly from their paper and comment thereon

Lattice comments - two important points to note here: (1) pre-fill w. noble argon gas purge and pressurization w. inert noble gas Helium (He) helps insure absence of Oxygen (as gaseous O_2) during hydrous pyrolysis of oil samples (protons required as reactants for LENRs are provided either from water (H_2O) or hydrocarbon molecules in the oil); (2) rotation of pyrolytic reaction vessel insures relatively uniform exposure of entire volume of reacting liquids to Au reactor walls during the course of experiments (if present, LENRs would be expected to occur in *nm*- to *µ*-scale, randomly scattered LENR-active 'patches' mainly on reactor walls; combined area of LENR 'patches' would comprise only a tiny percentage of total interior area of Au walls)

- ✓ "Rotation of the reactors was stopped briefly to facilitate fluid sampling during the course of the experiment. Sampling of oil, water and gas was conducted at the experimental temperature through capillary sampling tubes (gas analyses are reported elsewhere; see Kharaka & Lundegard, in prep.) ... main reactor chamber was connected to the sample exit port with gold capillary tubes (0.090 in o.d.) encased within 1/4 inch o.d. 316 stainless steel [SS] tubes ... first tube entered the reactor chamber only a short distance ... used to sample gases when the reactor was upright, and water when the reactor was inverted ... second tube was used to sample the oil. It extended approx. halfway into the reactor chamber, to a point within the oil phase. Other details of the procedure, including reactor specifications, are in Seyfried *et al.* (1979, 1987)."

Lattice Energy LLC

Discussion: Curiale *et al*., *Organic Geochemistry* (1992)

Description of experiments 5: Au-lined reactor as resonant E-M cavity

For readers' convenience, we will quote selected text directly from their paper and comment thereon

Lattice comments – it is important to realize that Curiale *et al.*'s Gold-lined Type 316 stainless steel pyrolysis reactor can also function as a resonant electromagnetic (E-M) cavity. While this may not be of very much significance in the context of conventional petroleum chemistry, it is extremely relevant to the possibility that LENRs might have occurred during such long-running hydrous pyrolysis experiments. For more details about such LENR resonant E-M cavities see:

"Lattice Energy LLC-Nickel Seed W-L LENR Nucleosynthetic Network"
L. Larsen - March 24, 2011
http://www.slideshare.net/lewisglarsen/lattice-energy-llcnickel-seed-wl-lenr-nucleosynthetic-networkmarch-24-2011

"Lattice Energy LLC - Nickel-seed LENR Networks"
L. Larsen - April 20, 2011
http://www.slideshare.net/lewisglarsen/lattice-energy-llcnickelseed-lenr-networksapril-20-2011

Elaborating just a little, a common factor amongst different types of mainly stainless steel reaction vessels (e.g., Type 316 SS) is that, on some length scales, resonant electromagnetic (E-M) cavities can potentially exist inside of all of them. Importantly, in certain experiments, vessels may also contain hydrogen isotopes in some chemical form. That, coupled with the presence of metallic 'catalysts' (e.g., Ni, Pd, Au, etc.) and/or aromatic rings + input of thermal energy (raise temperature), and/or pressure and time, can under proper conditions produce detectable LENR neutron capture products, e.g., ^{13}C from ^{12}C, ^{15}N from ^{14}N and 'new' elements previously absent, e.g., ^{4}He from C, etc. in parallel with ordinary types of chemical reactions

Lattice Energy LLC

Discussion: Curiale *et al.*, *Organic Geochemistry* (1992)

Description of experiments 6: observed effects, discussion of results

For readers' convenience, we will quote selected text directly from their paper and comment thereon

- ✓ "Minor flaking of the gold coating was observed when the reactor was emptied after the 300°C experiment with Iraq oil. The time at which this flaking occurred, and the time during which the stainless steel reactor wall was exposed to the oil/water/gas during the experiment, are unknown. However, the effect of this exposure is considered minor because the area of exposure is small (estimated to be less than 0.1% of the entire interior reactor surface). Furthermore, the trends observed in the Iraq oil experiment are very similar to those observed in the California oil experiment, in which flaking did not occur."

Lattice comments - some years ago, Lattice supported and conducted LENR experiments involving current-driven, aqueous electrolytic cells with various types of thin-film metallic cathodes in which very similar flaking of cathode surfaces was observed in localized 'damage spots' that had clearly occurred during device operation; identical types of flaking from metallic cathodes have also been reported by many other LENR researchers in experiments where transmutations had occurred (measured w. SIMS) and measurable excess heat was produced

Interestingly, tiny 0.1% of total reactor surface area that experienced delamination and flaking of thin plating of Au over Fe during Curiale *et al.*'s experiments is very consistent with what W-L theory would expect in condensed matter systems not deliberately optimized for making LENRs

Such flaking/delamination may occur because intense, highly localized heat produced at tiny LENR 'hot spots' magnifies differences in coefficients of thermal expansion, buckling thin layer

Lattice Energy LLC

Discussion: Curiale *et al.*, *Organic Geochemistry* (1992)

Description of experiments 7: procedures, results, discussion

For readers' convenience, we will quote selected text directly from their paper and comment thereon

- ✓ "Iraq and California oils were heated for 2 - 98 days at 300°C, and the California oil was heated in a separate experiment for 1-210 days at 200°C. In the 98 day experiments (300°C), approx. 5 ml of oil were removed after 2, 8, 19, 30, 58, 85 and 98 days, at the conditions described above. Two samples were taken after 98 days. The first (5 ml) was sampled at the temperature/pressure conditions of the reactor, whereas the second (the remaining oil in the reactor --- approx. 150 ml) was sampled after the reactor cooled to ambient conditions and was opened. In the 210 day experiment (200°C), approx. 5 ml of oil were removed after 1, 60 and 210 days. Specific sample identifications and pyrolysis times are given in Tables 1 (pressure/temperature data), 2 (elemental and isotopic data), and 3 (molecular data)."
- ✓ "Whole original and pyrolyzed oils were analyzed by inductively-coupled plasma emission spectrometry (ICP-AES; vanadium, nickel), isotope ratio mass spectrometry ($\delta\ ^{13}C$), capillary gas chromatography (n-alkanes and isoprenoids), and capillary gas chromatography-mass spectrometry (GCMS; steranes and selected terpanes). ICP-AES measurements were made on whole oil ash dissolved in an aqueous medium, as outlined by Odermatt & Curiale (1989, 1991) and Curiale (1992a). $\delta\ ^{13}C$ values were obtained using whole oil, closed-tube combustion methods. Oils were combusted as received, without removal of light ends; experimental details are reported elsewhere (Curiale, 1989, 1992a). Carbon isotope ratios are reported relative to the PDB standard [$\delta\ ^{13}C$]."

Lattice Energy LLC

Discussion: Curiale *et al.*, *Organic Geochemistry* (1992)

Description of experiments 8: presentation of observed data

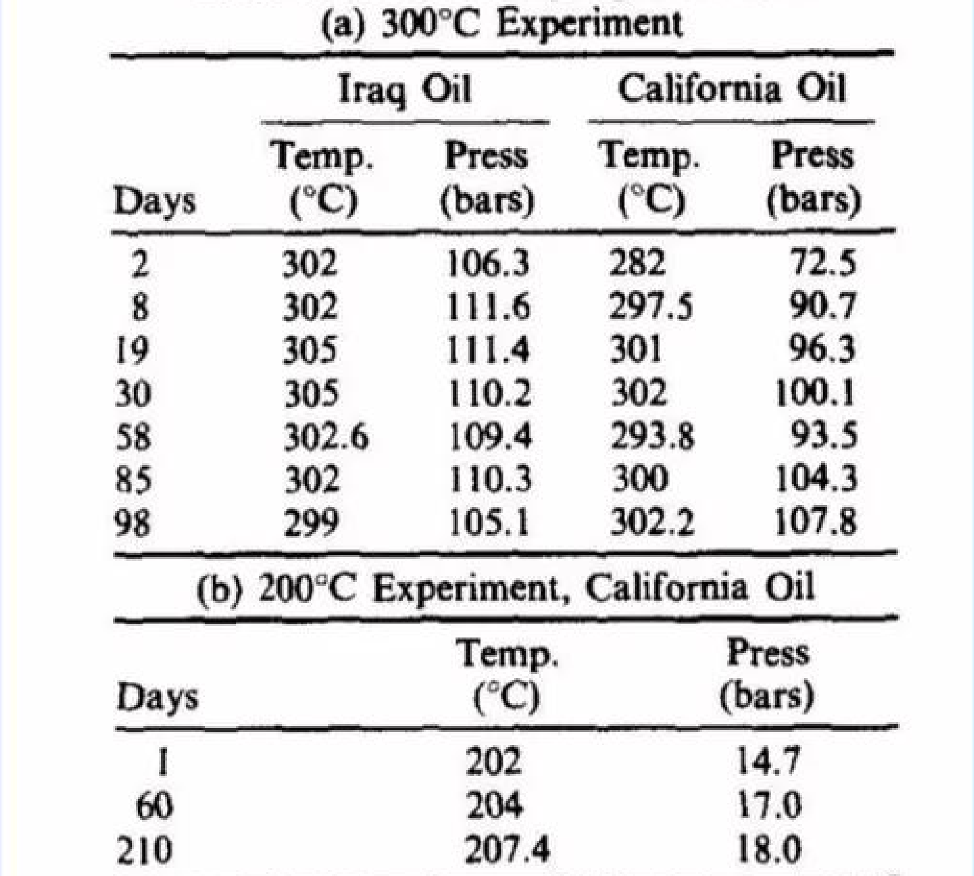


Table 1. Reactor sampling conditions
(a) 300°C Experiment

	Iraq Oil		California Oil	
Days	Temp. (°C)	Press (bars)	Temp. (°C)	Press (bars)
2	302	106.3	282	72.5
8	302	111.6	297.5	90.7
19	305	111.4	301	96.3
30	305	110.2	302	100.1
58	302.6	109.4	293.8	93.5
85	302	110.3	300	104.3
98	299	105.1	302.2	107.8

(b) 200°C Experiment, California Oil

Days	Temp. (°C)	Press (bars)
1	202	14.7
60	204	17.0
210	207.4	18.0

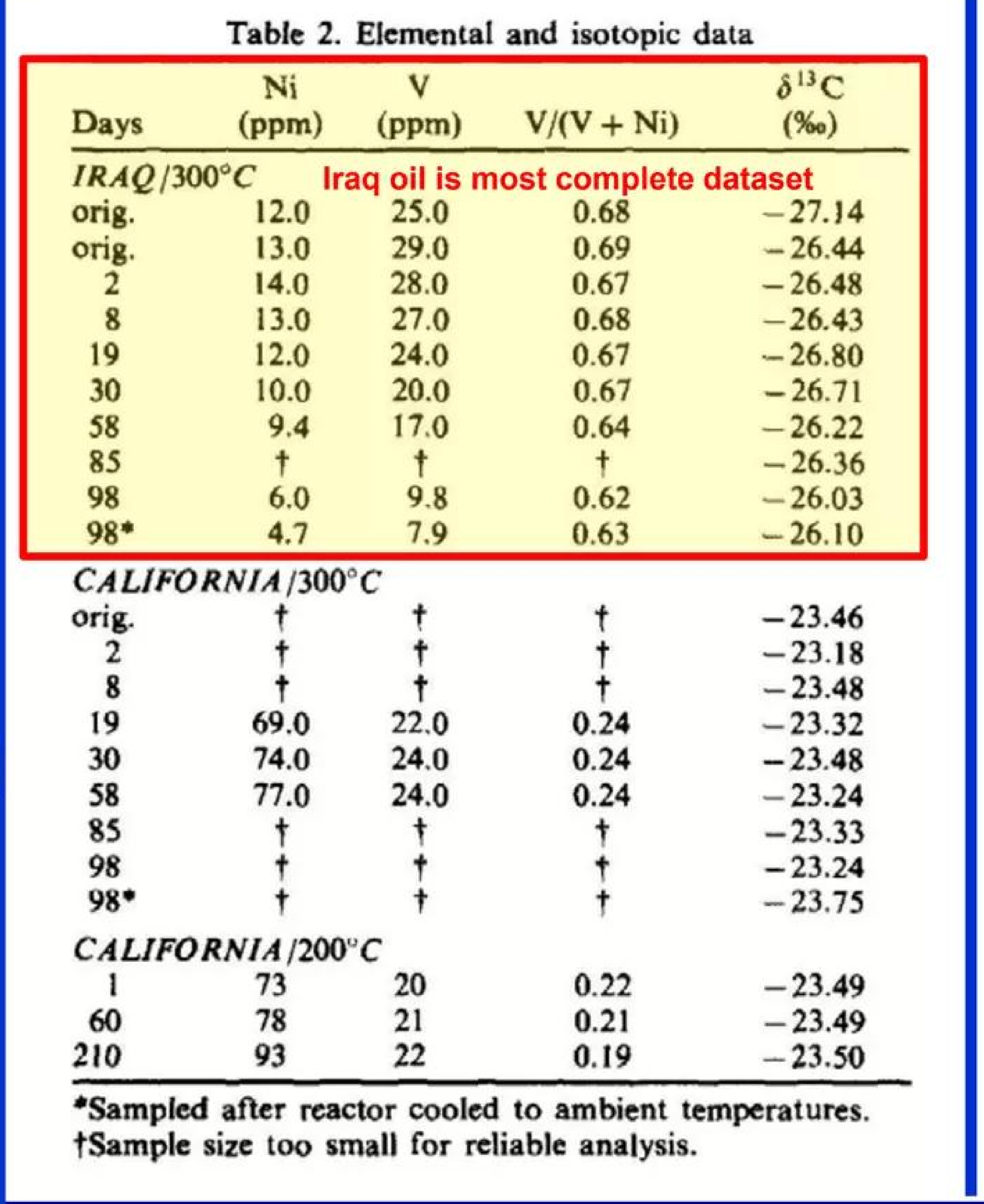


Table 2. Elemental and isotopic data

Days	Ni (ppm)	V (ppm)	V/(V + Ni)	$\delta^{13}C$ (‰)
IRAQ/300°C	Iraq oil is most complete dataset			
orig.	12.0	25.0	0.68	−27.14
orig.	13.0	29.0	0.69	−26.44
2	14.0	28.0	0.67	−26.48
8	13.0	27.0	0.68	−26.43
19	12.0	24.0	0.67	−26.80
30	10.0	20.0	0.67	−26.71
58	9.4	17.0	0.64	−26.22
85	†	†	†	−26.36
98	6.0	9.8	0.62	−26.03
98*	4.7	7.9	0.63	−26.10
CALIFORNIA/300°C				
orig.	†	†	†	−23.46
2	†	†	†	−23.18
8	†	†	†	−23.48
19	69.0	22.0	0.24	−23.32
30	74.0	24.0	0.24	−23.48
58	77.0	24.0	0.24	−23.24
85	†	†	†	−23.33
98	†	†	†	−23.24
98*	†	†	†	−23.75
CALIFORNIA/200°C				
1	73	20	0.22	−23.49
60	78	21	0.21	−23.49
210	93	22	0.19	−23.50

*Sampled after reactor cooled to ambient temperatures.
†Sample size too small for reliable analysis.

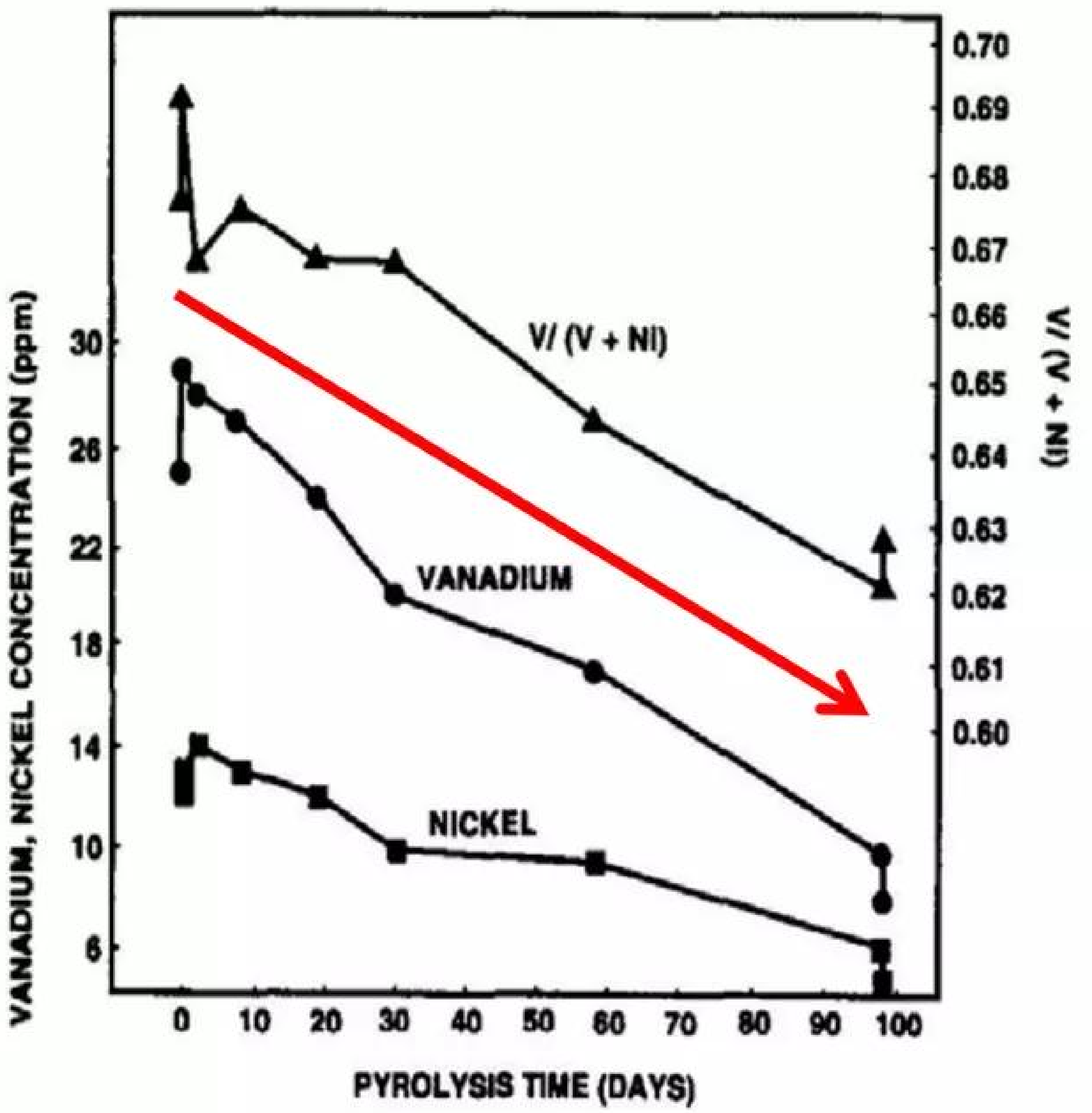


Fig. 1. Variation of vanadium and nickel concentrations (left axis; ppm) and V/(V + Ni) ratio (right axis) with pyrolysis time, for the Iraq oil pyrolyzed at 300°C. Note preferential loss of vanadium with increased heating time. Data are listed in Table 2.

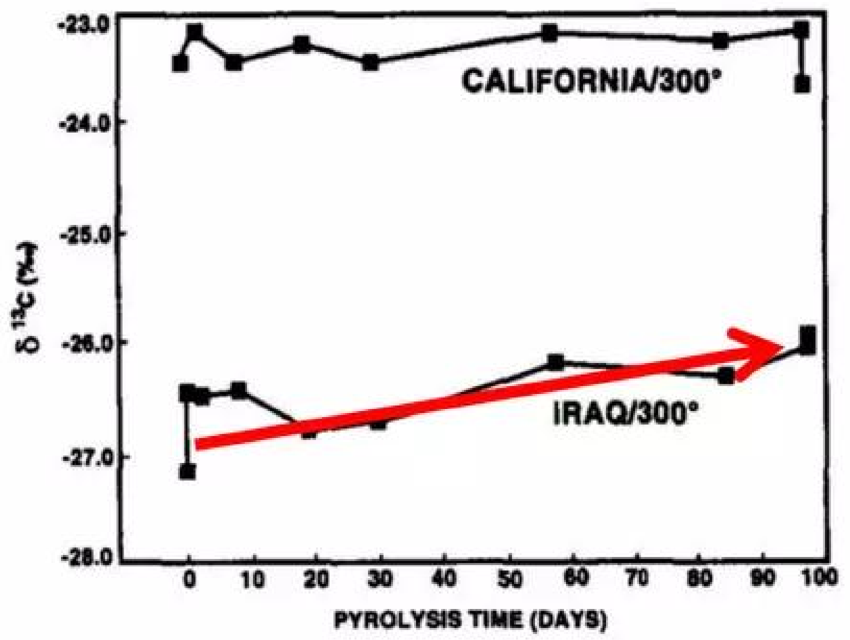


Fig. 2. Variation of carbon isotope ratio (whole, untopped oil) with time of hydrous pyrolysis, for the California and Iraq oils pyrolyzed at 300°C. Data are listed in Table 2.

Lattice comments: P/T and time data shown in Table 1; Carbon isotope measurements in Fig. 2; elemental and isotopic data shown in Table 2.; and lastly, V and Ni concentrations vs. pyrolysis time shown in Fig. 1

Lattice Energy LLC

Discussion: Curiale *et al*., *Organic Geochemistry* (1992)

Description of experiments 9: discussion of observed data

- ✓ "Elemental and isotopic data for the original oils (designated as 'orig' in Tables 2 and 3) and pyrolyzates are listed in Table 2. In some cases, pyrolyzed oils recovered from the California 300°C experiment were used for other experiments not described here. In these instances, the amounts of sample left for ICP-AES analysis were too low for reliable metal determinations."

- ✓ "In the Iraq/300°C experiment, both vanadium and nickel concentrations in the oils decrease significantly with increasing pyrolysis time. The V/(V + Ni) ratio also falls slightly. These metal data are plotted against pyrolysis time in Fig.1. The decreasing trend observed in the Iraq/300°C experiment is not evident in the California/300°C experiment, or in the California/200°C experiment (Table 2). Although the V/(V + Ni) ratio does appear to decrease in the California/200°C experiment, the decline (a) is at the margin of our analytical precision and (b) is accompanied by an *increase* in Ni concentration in the 210-day sample. A minor increase in Ni concentration is also observed with increasing pyrolysis time in the California/300°C experiment, although again this increase is at the limit of our precision."

- ✓ "Data in Fig. 1 indicate that vanadium and nickel are depleted in the Iraq oil during hydrous pyrolysis. Previous studies have documented similar results in anhydrously pyrolyzed crude oil (Hodgson and Baker, 1957). This may be due to the thermal destruction of tetrapyrroles (including metalloporphyrins) which are the sites of much, if not all, of the vanadium and nickel in the oil (Baker & Louda, 1983, 1986; Mackenzie *et al.,* 1980). Because the absolute concentration of these elements in the oils is decreasing with increasing pyrolysis time, both elements must pass into the water phase either as divalent cations (Kharaka & Lundegard, in prep.), or as organometallic complexes formed by reaction with the interior surface of the reactor. Alternatively, vanadium and nickel may become part of a solid phase residue during the experiment. Although formation of such a residue was not evident during our experiments, a char was formed during similar (but anhydrous) experiments by Hodgson and Baker (1957)."

Lattice Energy LLC

Discussion: Curiale *et al*., *Organic Geochemistry* (1992)

Description of experiments 10: discussion of observed data

- ✓ "Data in Table 2 may be used to calculate degradation rate constants for the elimination of vanadium and nickel from oil under the experimental conditions described (hydrous, 300°C). Our results suggest that metal loss in our experiments was a first order process ... values obtained for vanadium and nickel are 12.4 x 10^{-8} s^{-1} (y_{int} = 29.1 ppm; r^2 = 0.99) and 9.3 x 10^{-8} s^{-1} (y_{int} = 13.7ppm; r^2 = 0.96), respectively, and compare favorably with values extrapolated to 300°C from Hodgson and Baker's (1957) sealed tube anhydrous oil pyrolysis experiments (e.g. 13.9 x 10^{-8} s^{-1} for vanadium) ... similarity in rate constants for metal depletion during hydrous and anhydrous experiments is surprising ... suggests that the presence of water is not a controlling parameter in the destruction of organometallic complexes in oils during maturation (Kharaka & Lundegard, in prep.)."

- ✓ "Furthermore, because vanadium is lost from the oil at a greater rate than nickel, it is clear that the V/(V + Ni) ratio is not maturity-invariant in this experiment (Fig. 1). The decrease in this ratio with time, although minor (from 0.69 to 0.62), is experimentally significant (see below). This finding is in agreement with results of Hodgson & Baker (1957) but in contrast to some previous investigations. Several workers have found the V/Ni ratio to be invariant with most non-source effects (Costanoiltinides *et al*., 1959; see also the review by Branthaver & Filby, 1987), whereas Baker & Louda (1986) observed increasing V/Ni ratios with increasing maturity of petroleum porphyrins. It is noted that these previous studies were often conducted without significant controls on any of the four processes responsible for changes in metal concentrations in oils (i.e. original source input, thermal maturity, migration, and in-reservoir alteration --- see Curiale, 1992b). In contrast, the experimental design of our work eliminates non-maturity effects as possible causes of variance. In any event, it is noted that, even though analytically significant V/(V + Ni) ratio decreases were observed, the total drop [6% of the 0-1 V/(V + Ni) scale] is quite minor."

Lattice Energy LLC

Discussion: Curiale *et al.*, *Organic Geochemistry* (1992)

Description of experiments 11: discussion of observed data

Lattice comments: their statement "... *vanadium is lost from the oil at a greater rate than nickel ...*" is an interesting observation because it correlates very roughly with approximate direction of differences in neutron capture cross-sections of V and Ni isotopes measured at thermal energies

Stable isotope	Natural abundance	Neutron capture cross-section	Was element measured by Curiale et. al. ?	Lattice comment
^{50}V	~0.25%	~21 barns	Yes, but not isotope	Very long half-life
^{51}V	~99.75%	~4.9 barns	Yes, but not isotope	Trace metal in oil
^{58}Ni	~68.1%	~4.6 barns	Yes, but not isotope	Trace metal in oil
^{60}Ni	~26.2%	~2.9 barns	Yes, but not isotope	Trace metal in oil
^{12}C	~98.9%	~3.5 *millibarns*	Yes, isotope	Slight decrease, Iraq
^{13}C	~1.1%	~1.4 *millibarns*	Yes, isotope	Slight increase, Iraq
^{197}Au	100%	~98.7 barns	No, not measured at all	Only has 1 stable isotope; neutron capture transmutes Gold rapidly into various Mercury (Hg) isotopes
Note: capture cross-sections of Ni and V isotopes have never been measured at LENR ultra low momentum neutron energies (which are orders of magnitude lower than thermal neutrons); might vary greatly from thermal				

Lattice Energy LLC

Discussion: Curiale *et al.*, *Organic Geochemistry* (1992)

Description of experiments 12: discussion of observed data

Lattice comments: on a relative basis, Carbon shifts are subdued compared to dramatic decreases in concentrations of Ni and V measured via mass spec in sampled liquids. Interestingly, thermal neutron capture cross-sections are orders-of-magnitude lower for stable Carbon isotopes in comparison to isotopes of both Nickel and Vanadium

- ✓ **"Carbon isotopic data for all three experiments are listed in Table 2 and plotted in Fig. 2. Systematic variations in $\delta\ ^{13}C_{oil}$ were not observed in the California/300°C and California/200°C experiments, in contrast with minor changes in $\delta\ ^{13}C_{oil}$, (about 2‰) observed by Chung *et al.* (1991) during anhydrous pyrolysis of a Monterey crude. Minor increases in carbon isotope ratios are apparent in the Iraq/300°C experiment. The slight change in $\delta\ ^{13}C$ with pyrolysis time in the Iraq oil (Fig. 2) may result from increased thermal destruction (and conversion to gas) of the isotopically light *n*-alkanes with increased pyrolysis time, whereas these *n-alkanes* are in low starting concentrations in the California oil due to biodegradation (compare upper chromatograms in Figs 3 and 4). In general, our data support the conclusion that, in terms of whole oil $\delta\ ^{13}C$ values, isotope ratios provide a valuable, and largely maturity-invariant, oil-oil rock correlation tool in the case of these particular oils. However, carbon isotope ratios of oil will, in general, change with maturity because of (a) changes in the isotope ratio of compound classes (Schoell, 1984) and (b) differences in the isotope ratio of each individual compound in the oil, particularly the *n*-alkanes (Sofer *et al.,* 1991). Therefore one must be cautious in applying these results to other crude oils."**

Discussion: Curiale *et al*., *Organic Geochemistry* (1992)

Discussion of hydrous pyrolysis experiments 13: conclusions

Conclusions of Curiale *et al*.:

"Examination of elemental, isotopic and molecular compositions in oil hydrous pyrolyzates reveals systematic variations with increased time of heating in two oils. With increasing artificial maturity levels in the whole oil, (a) vanadium and nickel concentrations decrease by up to 60%, (b) V/(V + Ni) ratios decrease by approx. 0.06, and (c) carbon isotope ratios are 0.5s invariant (or change only slightly)."

Data appears to be consistent with an LENR process

Conclusions of Lattice:

Their data is very interesting and appears to be consistent with a nuclear process if a reasonable prosaic explanation for anomalous substantial decreases in Nickel and Vanadium concentrations cannot be found. In the W-L paradigm, Ni and V 'disappear' because they are transmuted via LENRs into other stable elements that were not measured by the experimentalists. In the Iraq/300 experiment, Carbon did become slightly more neutron-rich, but that observation could also be explained by a chemical fractionation effect (unlike the 'disappearing' Ni and V). Altogether, we would conclude that the data is intriguing and suggestive but certainly not conclusive. This suggests more measurements are needed, creating opportunities for curious experimentalists

Lattice Energy LLC

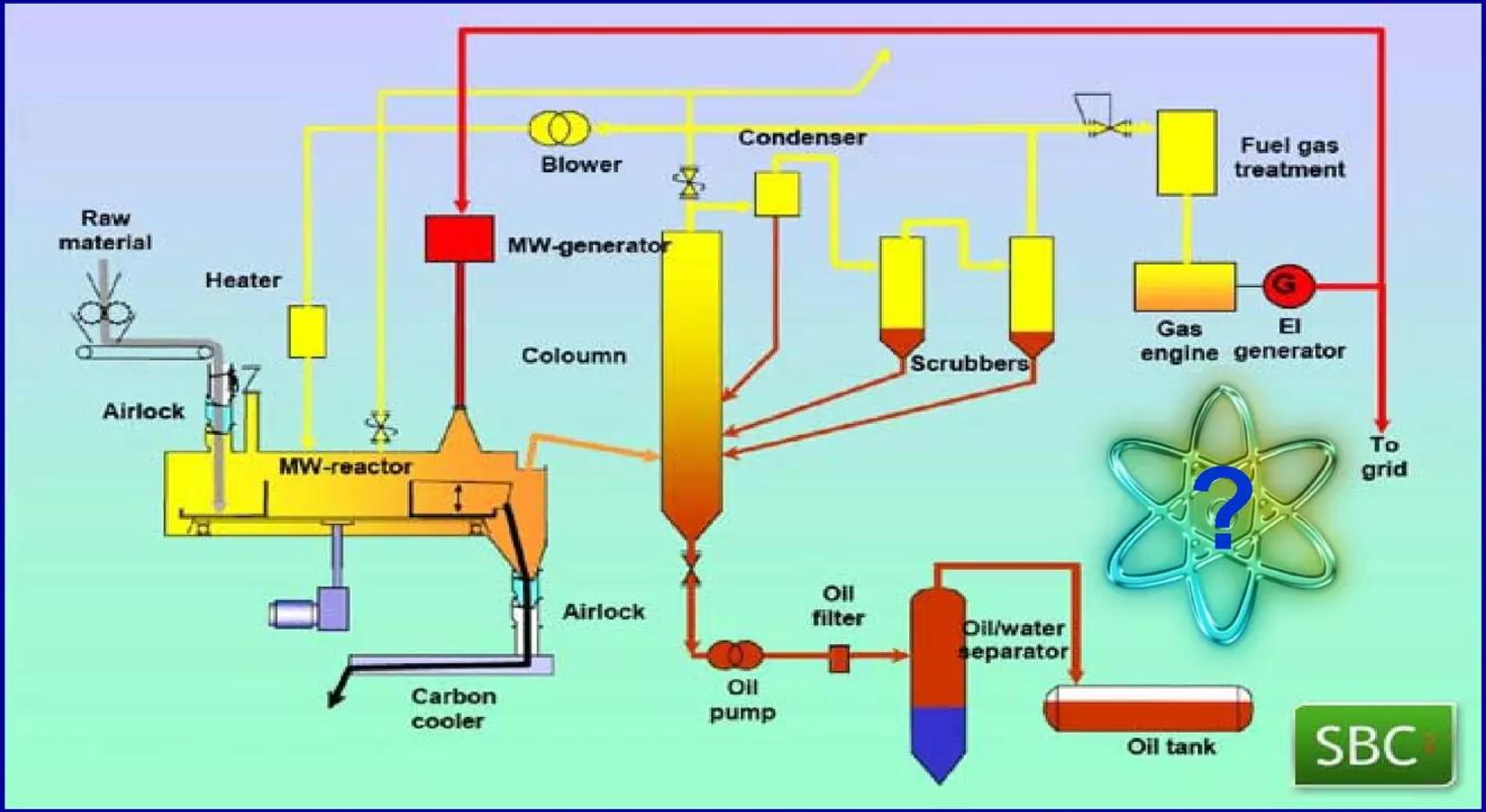
Are LENRs occurring at low rates in heat-driven pyrolysis?

Opportunities for intellectually curious experimentalists

- ✓ **Question**: how widespread is the occurrence of similarly difficult-to-explain anomalies with respect to elements (i.e., either mysteriously ‘disappearing’ and/or ‘new’ elements suddenly appearing - that might otherwise typically be peremptorily dismissed as mere ‘contaminants’) and/or isotopes (e.g., significant isotopic shifts) found in various observational data obtained from analyses of materials that have been subjected to different types of industrial pyrolytic processes?
- ✓ **Comment**: it may be fruitful for curious researchers to go back and reexamine relevant, previously published reports to see whether a reinterpretation of prior observations in light of possibility that LENR effects may provide better insight into and understanding of such data
- ✓ **Offer**: Lattice would be delighted to formally consult with companies and/or informally collaborate with academic researchers wishing to analyze/mine data and/or design experiments to collect more such data

Lattice Energy LLC

Commercializing a Next-Generation Source of Safe Nuclear Energy



Credit: Microwave-assisted pyrolysis - Scandinavian Biofuel, Oslo, Norway

> ***"When you have eliminated the impossible, whatever remains, however improbable, must be the truth."***
>
> **Sherlock Holmes**
> ***"The Sign of the Four"* 1890**