Keeping an Eye on Critical Commodities ... Uranium, Thorium, $^3$He, Rare Earths, and their Use in Support of the Environment

... Uranium & Nuclear Power are on the Move ...

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The AAPG Energy Minerals Division’s Uranium (Nuclear and REE) Committee (aka UCOM)

A YouTube version of this presentation with narration is also available (here).

2020 AAPG-EMD On-Line Conference: Let’s Confront and Tackle the Issues about Energy Resources and Use
But First, What is the Role of UCOM Within AAPG?

- The role of UCOM is to monitor, evaluate, and report on uranium activities in the U.S. and the world for the purpose of advising AAPG members and the general public on an energy source that competes with oil and gas in the generation of electricity for the general public.

- On the basis that uranium exploration and mine development depends on the demands of the nuclear power industry to fuel nuclear reactors to generate electricity, that industry must be monitored to observe the needs for production of uranium from the U.S. and around the world.

- An annual report is prepared by UCOM members led by the UCOM Chair with input coming from the three Vice-Chairs, the Advisory Group and from Special UCOM Consultants (more). UCOM contributes to AAPG and other publications as well (more).

- UCOM members also provide input to the I2M Web Portal for research purposes (History).
Members of the UCOM Committee:

UCOM Chair:

Michael D. Campbell, P.G., P.H., C.P.G., C.P.H., Chairman, I2M Consulting, LLC, Chief Geologist (Mining) / Chief Hydrogeologist (Environmental), Houston, TX (Ex-Teton Exploration Div., United Nuclear Corporation, and Texas Eastern Nuclear, Inc.), Founding Member of EMD in 1977, and Past President of EMD (2010-11), UCOM Chair since 2004.

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- Henry M. Wise, P.G., C.P.G., (Vice-Chair: Industry), US Ecology, TX (Founding Member, ex-US Steel, Uranium Div.)
- Steven S. Sibray, P.G., C.P.G., (Vice-Chair: University), University of Nebraska, Lincoln, NE
- Robert W. Gregory, P.G., (Vice-Chair: Government), Wyoming State Geological Survey, WY

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- Kevin T. Biddle, Ph.D., V.P., ExxonMobil Exploration (retired), Houston, TX (Founding Member EMD)
- James L. Conca, Ph.D., P.G., Senior Scientist, UFA Ventures, Inc., Richland, WA
- Gerard Fries, Ph.D., Orano Mining, KATCO JV, LLP, Nur-Sultan, Kazakhstan
- Michael A. Jacobs, P.G., Manager, D. B. Stevens & Assoc., Midland, TX (Founding Member of EMD, Ex-Tenneco Uranium Inc.)
- Roger W. Lee, Ph.D., P.G., Consulting Geochemist, TX
- Karl S. Osvald, P.G., U.S. BLM, Wyoming State Office Reservoir Management Group, WY
- Mark S. Pelizza, P.G., M. S. Pelizza & Associates, LLC, Plano, TX
- Arthur R. Renfro, P.G., Sr. Geological Consultant, Cheyenne, WY (Founding Member of EMD, Ex-Teton Exploration).
- David Rowlands, Ph.D., P.G., Rowlands Geosciences, Houston, TX

UCOM Special Consultants to the Uranium (Nuclear and Rare Earths) Committee:

- Bruce Rubin, Senior Geological Consultant, Millers Mills, NY (Founding Member of EMD, Ex-Teton Exploration - United Nuclear Corporation, General Public Utilities, Fuel Div.)
- M. David Campbell, P.G., Senior Principal and Senior Project Manager, I2M Consulting, LLC, Houston, TX. (Founder of MarineBio.org and the MarineBio Conservation Society.
- Robert A. Arrington, VP, Exploration, Texas Eastern Nuclear, Inc. (retired), College Station, TX (Founding Member of EMD in 1977)
Nuclear power plants operate by boiling water to turn turbines that generate electricity. Heat is generated by the fission that occurs when uranium cells are brought together and controlled by graphite rods. The uranium fuel and graphite rods are usually replaced every 5 years or so. After years of construction of nuclear power plants, the Hollywood movie "China Syndrome" was released. Only a few days later, the Three-Mile Island incident occurred. This brought massive coverage by the media pandering fear, but no one died, no one was irradiated.

A few years later, the Chernobyl accident occurred, killing 25 or so fire fighters and emergency personnel. This was a special case caused by poor design and incompetent management during the time of the Soviet Union and the “Cold War.” A number of children contracted thyroid cancer, but 99% were successfully treated, although a few died. The others recovered.

By 2011, Japan had constructed a large fleet of nuclear power plants, but in that year a large earthquake struck off-shore and sent a tsunami to the Japanese coastline killing 10s of thousands of people. A part of the tsunami broke through one of the protecting walls of a coastline nuclear power plant and flooded the back-up power supply that cooled fuel rods. This resulted in an explosion of hydrogen gas that was set-off by fires in one of the fuel rod storage facilities. Again, no one was hurt or killed at the plant although the media again over played seriousness of the incident.

The Fukushima incident sent off fears that went around the world, until the actual conditions came out by responsible media. The melt-downs of the fuel rods was managed properly. At least one of the reactors was out of service, but the damage was more psychological, than physical. Those people living near the plant left in a panic, and some have not yet returned. But, no one was hurt or killed at the plant although the media again over played seriousness of the incident.

The impact of the 2011 incident resulted in a worldwide 60% decrease in the price of yellowcake, the raw fuel which is subsequently refined into pellets suited for loading into nuclear power plants. Also, all of a sudden, too much yellowcake was being produced by mines worldwide because of the shutdowns, but because most of the fuel came from overseas to fuel American nuclear power plants, much of that production declined to preserve future revenues, until the excess fuel had been consumed. This resulted in many years of depressed prices for yellowcake.

In late 2019, the excess fuel supply was beginning to be consumed, which has prompted the yellowcake "spot" price to increase, but not enough to stimulate re-starts in U.S. uranium mines. Long-term contracts were not yet being sought by the nuclear utilities who buy the fuel as their fuel supplies reach a certain minimum. Recently, the DOD has supported a plan to provide some protection for U.S. mines by creating a Strategic Uranium Reserve, to guarantee uranium price levels — but this has not yet been consummated.

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### Issues or Reality?

- Nuclear power has the best safety record in the major energy industry (more).
- Nuclear power can, and does compete with fossil fuels to generate electricity (more).
- Uranium fuel costs to nuclear utilities are usually less than 5% of operating costs.
- Nuclear Power is climate and business friendly (more).

### On Nuclear Power for the Generation of Electricity:

- Nuclear power plants operate by boiling water to turn turbines that generate electricity.
- Heat is generated by the fission that occurs when uranium cells are brought together and controlled by graphite rods.
- The uranium fuel and graphite rods are usually replaced every 5 years or so.
- After years of construction of nuclear power plants, the Hollywood movie "China Syndrome" was released. Only a few days later, the Three-Mile Island incident occurred. This brought massive coverage by the media pandering fear, but no one died, no one was irradiated.
- A few years later, the Chernobyl accident occurred, killing 25 or so fire fighters and emergency personnel. This was a special case caused by poor design and incompetent management during the time of the Soviet Union and the "Cold War." A number of children contracted thyroid cancer, but 99% were successfully treated, although a few died. The others recovered.
- During the next 30 years, the U.S. did not construct one new nuclear power plant, and coal and natural gas provided the bulk of the energy. France, Russia, China and others continued to build new nuclear power plants, with France receiving all power from nuclear power at one stage.
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The nuclear waste is being managed safely at the Plant Sites, for now, even though the Federal Government & Congress failed to provide a national storage site, as required by law.

- **Yucca Mountain Facility** in Nevada cost $ Billions ...

- Why not expand the operating **Waste Isolation Pilot Plant (WIPP) Facility** in New Mexico?

- U.S. generates ~ 2,000 metric tons of used uranium fuel/yr.

- Total waste produced since 1950s = ~83,000 metric tons, which would fit in a football field stacked in containers to a depth of 10 yards (30 feet).
At End of 2019: 441 Operational Nuclear Reactors World-Wide (Many more to come in Asia). In U.S., 57 plants w/95 reactors in 29 states, which requires ~68 million pounds (34,000 tons) of uranium/yr. from mines to fuel 95 reactors. That is about 8,500 bbls of yellowcake from mines.

New Construction, but is it sufficient to meet the climate needs? In 2020, there are more than 54 reactors under constructions in the world (more). 2 in the U.S.

New Nuclear Technology may meet the future demand for electricity, SMRs, etc. (more).

But EIA projects >> in Renewables + NG? (more), (more), etc.

Impact of inherent flaws in the economics of wind and solar projects involving overlooked O&M costs becoming evident (more),

Wind and Solar energy consumer prices are increasing (more), with NG as Grid Back-up?

Nuclear energy costs are declining with SMRs,

World Nuclear Status (History).
Characteristics of SMRs

- SMR units to power a small town or a neighborhood,
- Reasonable capital and operating costs,
- Minimal waste handling,
- Rapid construction and installation, and
- Safe to operate and to refuel.

- Small Nuclear Technology to join the large technology.
- Small Nuclear Reactors (SMRs) to add nuclear power to generate electricity for cities and in remote areas.
- One or more SMRs at utility transformer sites or remote sites.
- History of SMR development by industry (more).
“From where do we get the uranium resources to fuel our 95 nuclear reactors in U.S.?"

1. U.S. needs secure source of uranium from within the U.S., if possible (History) and (now).

2. What is U.S. Government doing? (History).

3. Canada and Australia should be our partners in providing uranium, if needed.

4. Where are the uranium deposits in the U.S.?  

Uranium Resources of the United States

- Uranium Strategic Reserves provided by American Uranium Mining Companies? Maybe ....
Drilling “roll-front” uranium deposits....

Geological sampling followed by geophysical logging to identify uranium mineralization zone.

Texas, for example:

Drilling and Developing American Uranium Resources in Texas, Wyoming, Utah, New Mexico, South Dakota, Nebraska, Colorado, Virginia and Alaska, etc.

Exploration Methods (more)
Principal Types of Uranium Mineralization

- Roll-Front uranium mineralization exploration methods are well developed (more).
- Exploring for uranium in carbonatites and peralkaline igneous rocks more complicated.
- Exploring for unconformity-related uranium starts with aerial and ground geophysics.
The financial health of the U.S. uranium industry depends on a reasonable price for yellowcake to fuel nuclear utilities (history).

A Yellowcake price in the range of ±$50-$60/pound is needed for U.S. in situ mines, whereas many high-grade (underground) / open-pit mining operations need less to make a reasonable profit (more).

Overseas government support of mining introduces advantages not available to private industry in the U.S.

Opposition by some media and groups to the use of nuclear power and uranium mining is funded by all competing energy sources (history).

Russia does not own 20% of U.S. uranium reserves (more).

Russian company (Uranium One, Inc) has widespread interests in nuclear power and owns significant supplies within Russia and in Kazakhstan, Tanzania, & Mozambique. (History).

Russian company does own operating mines in Wyoming, (i.e., Christensen Ranch / Irigaray mines) & exploration properties in Colorado, Utah and Texas.
Conclusions:

- Uranium will be needed to fuel nuclear power plants until fusion power arrives, followed by a long transition period from fission to fusion power plants … 50 years or so.

- Uranium resource occurrences are widespread in the world. To power fusion plants, $^3$He resources are available on the Moon (more).

- The economics of developing any particular deposit depends on price of yellowcake, cost to produce, and local, state, and federal support of nuclear power, e.g., Germany, Japan.

- The U.S. uranium industry could supply most of the fuel needs of the American nuclear utility industry, with supporting supplies to come from Canada and Australia, and other friendly countries, if necessary.

- Employment in the geoscience fields will increase, e.g., Nuclear, Mining, Geothermal, Environmental, and NASA & Aerospace Industry for Off-World Exploration … (more).

- Employment links: (AIPG, US), (UK), (Canada), and (Australia). Buckle-up!

UCOM monitors uranium, thorium, and associated rare-earth exploration & development in a variety of ways: ............................UCOM website (here), and via the I2M Web Portal (here). Also see 2020 ACE Presentation on REE (here).

Note: A PDF version of this presentation that contains links and references is available (here = https://i2massociates.com/downloads/UCOM-Issues2020ShortSlides.pdf).
Selected References:


Questions of Issues or Reality?