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A Potential Phosphate Crisis — Editorial by Philip H. Abelson, *Science*, March 26, 1999

Phosphate is a crucial component of DNA, RNA, ATP, and other biologically active compounds. Microbes, plants, and animals — including humans — cannot exist without it. Rocks containing phosphate have been discovered and are being mined at minimal cost. But resources are limited, and phosphate is being dissipated. Future generations ultimately will face problems in obtaining enough to exist.

The current major use of phosphate is in fertilizers. Growing crops remove it and other nutrients from the soil. Long-term research at the Morrow agricultural plots of the University of Illinois at Urbana-Champaign has corroborated the fact that even the best land loses fertility unless nutrients are replenished. At the Morrow plots, there is a threefold or greater difference in yields of corn between fertilized areas and untreated ones. Most of the world's farms do not have or do not receive adequate amounts of phosphate. Feeding the world's increasing population will accelerate the rate of depletion of phosphate reserves.

Corn seeds, which are a major source of food for cattle, swine, and poultry, contain substantial amounts of phosphate. About 75% of it is in the form of phytate, a water-insoluble compound. When the seeds sprout, enzymes are created that release phosphate from the phytate, making it available for biological activities. When seeds are fed to ruminants, bacteria in the rumen degrade some of the phytate, providing phosphate for use by the animals. But nonruminants such as poultry, swine, and people do not have an efficient system for making phosphate available from phytate. They excrete most of it. Ultimately, some of the phosphate excreted contributes to water pollution and eutrophication and becomes unavailable for further use.

Recent scientific research has resulted in ways to diminish the loss of phosphate. One of the methods was described at the recent AAAS annual meeting in Anaheim, California. Adolphus van Loon of Hoffman-La Roche, Basel, Switzerland, reported on research results that facilitate the release of phosphate from feed prepared for chickens and hogs. One of his colleagues conducted many successful experiments to improve the stability of phytase enzymes, which catalyze the breakup of phytate. The DNA coding for phytase that is present in thermophilic bacteria was altered to produce more highly thermostable enzymes. These are incorporated in feed when it is initially being cooked. Experiments have demonstrated that as much as one-third of the phytate phosphate is made available when monogastric animals are fed the improved feed. Van Loon estimated that annual sales will total as much as $500 million.

Another approach to the phytate problem has been attempts to reduce the amount of phytate in seeds; however, studies using this approach usually found that when the phytate content was decreased substantially, the seeds did not germinate, or if they did, they did not give rise to healthy plants. A breakthrough was achieved when Victor Raboy and his colleagues at the U.S. Department of Agriculture Agricultural Research Service in Aberdeen, Idaho, obtained useful mutants of corn seeds. Although the seeds contain relatively little phytate, they give rise to productive plants. Phosphate needed by the seed is stored safely by a mechanism not yet determined.

Growing and feeding experiments are currently being conducted. In one study, University of Missouri scientists conducted experiments involving analysis of waste from pigs fed either unmodified or low-phytate corn. Pigs who were fed the low-phytate corn showed, on average, a 37% reduction in phosphorus excreted. In growing pigs, 64% of the phosphorus in low-phytate corn was available, as compared with 10% from genetically similar corn with normal phytate levels.

The rate at which U.S. farmers will adopt low-phytate varieties of corn will depend on whether seeds also provide a combination of traits that include higher yield, increased energy for feed, and resistance to pests and herbicides. Ultimately this objective will be achieved.

Accomplishments such as these that lead to the conservation of phosphorus will avert a crisis in phosphate availability in the short term, but further research is needed to avert problems in the long term.

A Bottleneck in Nature

Earth is not getting larger; however, every year there are more and more humans wanting more and more non-renewable natural resources, and every year Earth's non-renewable resources are being lost. Earth is exactly like an aquarium kept in your living room, except that it is larger, and is kept in empty space. You cannot just keep adding fish to any aquarium indefinitely, and you cannot remove a little water each day indefinitely. In the same way, at some point the human demand upon nature must be stabilized, and Earth's nonrenewable natural resources must be conserved.

Because of this insight, we are now going to talk about phosphorus. This is *not* because backyard naturalists need to know a lot about phosphorus, but rather because of these two points:

- We should all become accustomed to analyzing the world around us and pinpointing critical situations needing our attention (*a rare species requiring protection, a source of pollution that should be stopped, a local plan to convert a forest to a parking lot that must be protested..*.)

- We should become accustomed to seeing the world we live in as a web of life with some parts more fragile and more vulnerable than others.

OK, here we go with phosphorus...

Maybe you've had this experience: You're sweating and some butterflies or bees land on you and begin "drinking" your sweat. Sometimes certain butterflies get so involved in their sweat-drinking that you can actually pick them up by their wings.   What's going on here?

What's happening is that these creatures need mineral elements in your sweat such as potassium, magnesium, and calcium. Their need for these minerals is so great that if they didn't have them they'd die. And these minerals are often not easy to acquire in nature.

This may strike you as strange, especially if you know that these mineral elements are prime ingredients of Earth's crust. If you could scoop up the entire Earth's crust — the several-miles-deep rock and mineral portion of we live on — and separate by weight the mineral elements it's made of, about 3.6% of it would be calcium, 2.6% potassium, and 2% magnesium...So, if these minerals are so common wherever there is ordinary dirt and rocks, why would butterflies and bees get so excited about finding some in our sweat?

The problem is that these minerals dissolve in water. They're soluble. When it rains, if an atom of these minerals comes loose from the piece of rock or soil particle it's probably spent millions or billions of years stuck in, that atom (that *ion*, if you want to be technical) will be washed away, dissolved in the water. Probably it will flow into streams, then rivers, then finally into the oceans. Every rain flushes soluble mineral elements out of the landscape into our streams.

Not all liberated mineral atoms rush immediately to the sea. An important "detour" a newly-freed mineral can make is to be latched onto by a living organism. Maybe the root of a plant will take in the water the atom is dissolved in, and then the atom may well become part of that plant's body; and if that plant is eaten by an animal, the atom may become part of the animal's body.

In fact, *all life needs these minerals*. Life simply doesn't happen without them. We're not just speaking of calcium, potassium, and magnesium…The last time I looked, all of these mineral elements were absolutely required for *plants* to stay alive: **nitrogen, phosphorus, potassium, calcium, magnesium, sulfur, boron, chlorine, iron, manganese, zinc, copper, molybdenum**, and **nickel**.

For example, at the heart of *every* molecule of chlorophyll, there is an atom of magnesium; so, without magnesium photosynthesis is impossible, and without photosynthesis green plants and higher animals that eat the plants can't exist. Every protein molecule has an atom of nitrogen in it, and you know that there can't be muscles and many other things without protein. There can't be red blood cells without the iron in hemoglobin molecules... On and on it goes with each required mineral element.

Once it sinks in that these mineral elements are really *needed* for life — not like "I need a hamburger with pickles" but like "I need air" — then this question arises: Which of the above mineral elements do organisms stand the greatest chance of running out of?

The answer is: **Phosphorus**.

In fact, Isaac Asimov, an important science writer, has defined phosphorus as "life's bottleneck." This is true even though phosphorus is by no means the rarest mineral element. If you have a miniscule amount of something but only need a tiny, tiny bit of it, then that's less critical than if you have a fair amount of something, but you need a lot of it... Asimov noticed that some mineral elements are more common in organism bodies than in the surrounding environment. Obviously, that organism has needed to *concentrate* that element in itself. The degree of concentration of that element in the organism's body, then, becomes a good indication of these two things:

- how much organisms need that element
- how available it is in the environment

Asimov noted that phosphorus composes about 0.12% of an average soil, yet a much greater percentage of an alfalfa plant's body, about 0.7%, is phosphorus; therefore, the "concentration factor" for phosphorus is about 5.8 (0.7/0.12)… No other mineral element even comes close to having a concentration factor as great as phosphorus has. The closest is sulfur with 2.0, then chlorine with 1.5. All the rest have less than a factor of 1… Therefore, if there are more and more organisms needing mineral elements, or if the living ecosystem is more and more depleted of its resources, which mineral element will come into short supply first?

Phosphorus.

… And since phosphorus is a mineral element that organisms absolutely must have to stay alive, it doesn't much matter whether there are enough of all the other elements... Yet phosphorus leaches from our soils, is removed from the land in the crops we harvest, and flows down our drains whenever we use phosphorus-rich detergents or flush the commode (phosphorus was in the land, then in the agricultural crop we ate, the phosphorus passed through us, and now we're flushing it away...) and phosphorus ends up flowing into our streams and rivers and ultimately to the oceans. There it settles into mud and is not returned to the land except by geological processes requiring millions of years. Well, there are minor detours: Some phosphorus will bond with mineral particles, some of it reaching the ocean is returned in the droppings of sea birds and in fish caught there and eaten inland... but for the vast majority of phosphorus atoms, once they become dislodged from their rock and mineral parents they begin a one-way trip to the ocean; however, we're not going to run out of phosphorus anytime soon. There's no need to start hoarding phosphorus.

But it *is* time to become concerned about the long-term effects of the enormous worldwide loss of essential mineral elements through soil erosion and the lack of recycling of our organic wastes. It *is* time to begin seeing the Earth as a very vulnerable and beautiful aquarium of fixed size set in empty space.

This is a guest post by Patrick Déry and Bart Anderson. Patrick Déry is a physicist, energy, agriculture and environment analyst and consultant in Quebec, Canada. Bart Anderson is a former reporter, teacher and technical writer; he currently is co-editor of Energy Bulletin

Peak oil has made us aware that many of the resources on which civilization depends are limited.

M. King Hubbert, Co-founder of Technocracy Inc. and later… A geophysicist for Shell Oil, found that oil production over time followed a curve that was roughly bell-shaped. He correctly predicted that oil production in the lower 48 states would peak in 1970. Other analysts following Hubbert's methods are predicting a peak in oil production early this century.

The depletion analysis pioneered by Hubbert can be applied to other non-renewable resources. Analysts have looked at peak production for resouces such as natural gas, coal and uranium… In this paper, Patrick Déry applies Hubbert's methods to a very special non-renewable resource - **phosphorus** - a nutrient essential for agriculture.

In the literature, estimates before we "run out" of phosphorus range from 50 to 130 years. This date is conveniently far enough in the future so that immediate action does not seem necessary. However, as we know from peak oil analysis, *trouble begins not when we "run out" of a resource, but when production peaks*. From that point onward, the resource becomes more difficult to extract and more expensive.

Physicist Déry applied the technique of Hubbert Linearization to data available from the United States Geological Survey (USGS) to phosphorus production in the following:

- The small Pacific island nation of Nauru, a former phosphate exporter.
- The United States, a major phosphate producer.
- The world.

He tested Hubbert Linearization first on data from Nauru to see whether he could have predicted the year of its peak phosphate production in 1973. Satisfied with the results, he applied the method to United States and the world. He estimates that U.S. peak phosphorus occurred in 1988 and for the world in 1989.

Phosphorus — its role and nature

Phosphorus (chemical symbol P) is an element necessary for life. Because phosphorus is highly reactive, it does not naturally occur as a free element, but is instead bound up in phosphates. Phosphates typically occur in inorganic rocks.

As farmers and gardeners know, phosphorus is one of the three major nutrients required for plant growth: nitrogen (N), phosphorus (P), and potassium (K). Fertilizers are labeled for the amount of N-P-K they contain (for example 10-10-10).

Most phosphorus is obtained from mining phosphate rock. Crude phosphate is now used in organic farming, whereas chemically treated forms such as superphosphate, triple superphosphate, or ammonium phosphates are used in nonorganic farming.

Philip H. Abelson writes in *Science*: The current major use of phosphate is in fertilizers. Growing crops remove it and other nutrients from the soil... Most of the world's farms do not have or do not receive adequate amounts of phosphate. Feeding the world's increasing population will accelerate the rate of depletion of phosphate reserves, —— resources are limited — and phosphate is being dissipated. Future generations ultimately will face problems in obtaining enough to exist.

It is sobering to note that phosphorus is often a limiting nutrient in natural ecosystems; that is, the supply of available phosphorus limits the size of the population possible in those ecosystems.

More information:

- Understanding Phosphorus and its Use in Agriculture from the European Fertilizer Manufacturers Association.
- Phosphate Primer by Florida Institute of Phosphate Research.

Prospect of a Phosphorus Peak

In his frightening book *Eating Fossil Fuels* , Dale Allen Pfeiffer shows that conventional agriculture is as oil-addicted as the rest of society. A decline in oil production raises questions about how we will feed ourselves.

In the same way, agriculture is addicted to mined phosphates and would be threatened by a peak in phosphate production. As the U.S. Geological Survey (USGS) wrote in summary on phosphates (PDF): There are no substitutes for phosphorus in agriculture… Fortunately, phosphorus — unlike oil — can be recycled. Responses to a phosphorus peak include re-creating a cycle of nutrients, for example, returning animal (including human) manure to cultivated soil as Asian people have done in the not-so-distant past.

Hubbert Linearization

Tools that have been used for analyzing peak oil can be applied to phosphate production. As we will see, phosphorus production follows a more-or-less bell-shaped (parabolic) curve, just as oil production does.

Hubbert's parabolic curve is based on a differential equation explained by Stuart Staniford: The idea behind the equation is that early on, the oil industry grows exponentially — the annual increase in production is proportional to the total amount of knowledge of resources, oil field equipment, and skilled personnel, all of which are proportional to the size of the industry... Later, however, the system begins to run into the finiteness of the resource — it gets harder and harder to get the last oil from the bottom of the depressurized fields, two miles down in the ocean, etc, etc… To estimate future production and total production, some analysts have turned to the technique of Hubbert Linearization (H-L).

Hubbert Linearization was first developed by geologist Kenneth Deffeyes, an associate of M. King Hubbert. The technique has been discussed by analysts such as Stuart Staniford, Jeffrey J. Brown, and Robert Rapier at The Oil Drum. The term Hubbert Linearization was coined by Stuart Staniford.

In Hubbert Linearization, the production data from the bell-shaped Hubbert curve is plotted as a line. On the graph: the y-axis (vertical) is P/Q where P = annual production and Q = total production to date and the x-axis (horizontal) is Q (total production to date).

By extending the line in the graph, one can estimate Ultimate Recoverable Reserves (URR) for the region (Qt).

This paper purposely minimizes the math so as to reach a wide audience; however, much more detail on H-L is available online. For example:

Hubbert Linearization (Wikipedia)
In Defense of the Hubbert Linearization Method
Another Way of Looking at CERA by Stuart Staniford
When Does Hubbert Linearization Work? by Stuart Staniford
Predicting the Past: The Hubbert Linearization by Robert Rapier (H-L skeptic)

Applying Hubbert Linearization to Phosphates

For the purposes of this paper, Déry looked at data for commercial phosphate (26-34% of P_2O_5. Other reserves of rock phosphate with lower concentrations of P_2O_5 do exist, but, just as with tar sand for oil production, they are more costly to exploit — economically, energetically, and environmentally.

Using data from United States Geological Survey (rock phosphate production historical data series), Déry did a Hubbert Linearization for United States and for world rock phosphate production… Results were stunning. The theoretical logistic curve fits almost perfectly with the real data curve. Déry found that we have already passed the phosphate peak for the United States (1988) and for the world (1989).

Nauru

Those results seemed too perfect, however, so Déry tested the method on an almost-depleted region of rock phosphate production, a case similar to that of United States for oil. A small island in the South Pacific called Nauru appeared to be an ideal case. The Nauru Island is 21 km^2 with only one economic resource (besides being a fiscal paradise!): rock phosphate. This resource has been almost entirely depleted since 2005.

According to the CIA World Fact book: ...intensive phosphate mining during the past 90 years — mainly by a UK, Australia, and NZ consortium — has left the central 90% of Nauru a wasteland and threatens limited remaining land resources.

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For Russia, an end to growth is in sight, By Dave Cohen — August 15, 2007, by *ASPO-USA*

I intend to live forever. So far, so good. — *Comedian Stephen Wright*

Russia's resurgent oil production has fueled growth outside of the Organization of Petroleum Exporting Countries (non-OPEC) since 1999. The end is now likely in sight for yearly increases from the Federation. Growth has slowed since 2004, and although most analysts expect increases to continue in the near term, Russia is poised to peak or plateau sometime in the 2010-2012 period. If you are concerned about peak oil, it is necessary to track events in the world's largest oil producer. The eventual outcome is uncertain, but a peak in Russia's oil production in the medium-term seems all but assured.

The Energy Information Administration's (EIA) data has Russia's 2007 oil production at 9.846 million barrels per day (b/d, 5-month average), where oil includes crude, condensate, and natural gas liquids. Their graph shows the longer trend. Production is expected to surpass 10 million b/d sometime this year.

The Paris-based International Energy Agency's (IEA) Medium-Term Oil Market Report anticipates slower growth in Russia's production. Output peaks at 10.61 million barrels a day in 2011 and declines in 2012. The IEA qualifies their forecast, saying that "extrapolating a decline in Russian production in the longer term [after 2011] would be ... premature before examining post-2012 prospects (field developments) in detail." The Russian Ministry of Economic Development does not feel the same need for caution. *Pravda's* Stable oil production to make Russia world's leading economic power by 2020 (July 25, 2007) reports that the ministry expects oil output to stabilize at 10.6 million b/d (530 million tons per year) sometime in the future.

Russia is unusual nowadays in that almost all of their production is inland. TNK-BP's 2006 Annual Report shows how Russia's production growth has moderated over the last four years when offshore developments (mostly Sakhalin) are excluded. Russia's future output depends on the usual competition between managing dwindling production in old depleting fields and putting new oil projects on-stream. Sufficient investment must be available to support both activities.

Vladimir Putin's government has two conflicting goals. The Federation must encourage oil exploration and production (E&P) while taxing the produced oil to maintain government revenues. Russia's Oil Tax (*Forbes*, June 15, 2007) reports on this juggling act.

The Russian government has sought to maximize the benefits of the country's oil wealth through a mixture of taxation and direct intervention. As oil prices have increased, government take has grown, although there are signs that high marginal tax rates, coupled with uncertainty over future policy, has dampened the level of production growth. The government has also sought to capture more value from the processing of crude oil through the use of export duties though this strategy may lead to problems in the future... Policy regarding oil ... has been to encourage indigenous companies but also maximize the state's share of revenue, while keeping domestic prices as low as possible.

Russia constantly adjusts the Mineral Extraction Tax (MET) rate formula and the duties paid on exports based on the West Siberia Urals blend price to keep the right balance. Russian oil companies (*Whiskey & Gunpowder*) are always lobbying (*Moscow Times*, August 8, 2007) to get the tax rates decreased so that more of their profits can be plowed back into E&P. From the *Times*:

> A growing chorus of industry participants, including LUKoil's CEO Vagit Alekperov and Alfa Bank analyst Dmitry Loukashov, is calling for lower taxes to facilitate investment and new production. Russia has seen output growth slump to less than 3 percent last year from 11 percent in 2003 as field development costs have soared, according to British Petroleum.

Beyond burdensome tax rates, the Russian oil companies suffer from the same upstream capital costs inflation (*ASPO-USA*, August 8) that affects the world's oil & gas industry. This is why the IEA cites both an "uncertain investment climate and tight drilling/service capacity" as potentially lethal constraints on new oil developments.

The oil price remains favorable for Russian oil companies, but the Urals blend typically trades "at a discount of around $3 to $5 to the benchmark Brent blend" (*Moscow Times*, August 16, 2005). Russia actually has four export oil blends, and it is possible that one of them, REBCO, could soon replace the Urals benchmark "as the basis for calculating supply prices, export duties and [the] mineral extraction tax" (*Ria Novosti*, October 10, 2006).

Turning now to geological "below ground" factors, the choice of a decline rate in Russia's existing production base is crucial to predicting their future oil production levels. The IEA based their estimates on a 3% rate, but considered the effects of other values as well. If a 5% decline rate is used, Russian production never reaches 10.5 million b/d. Assuming steeper rates yields concomitantly lower peak production levels by 2011.

The IEA's assumption about the decline rate is similar to that used in John Grace's study[2] Russian Oil Supply: Performance and Prospects (*Oxford Institute for Energy Studie*s, 2005). The EIA's Russia Oil Analysis contains Table 1 taken from Grace's book. The table list selected "pre-peak" and "post-peak" Russian oil fields. The EIA explains —

> In the upcoming decade, a few major oil fields (Table 1) will contribute to most of Russia's supply growth and others will offset decreasing production from mature fields. In 2004, around 20 percent (or 1.8 million bbl/d) of Russia's oil production came from fields that had already produced 80 percent of their total recoverable reserves. Achieving continued growth at post-peak fields will become more problematic as oil companies run out of easy and less costly opportunities to manage the rate of decline.
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> "Pre-peak" fields, which have come online in the last decade, can add between around 1.2-1.5 million bbl/d to Russian supply according to John Grace's recent analysis of Russia's oil supply.

One of the notes to Table 1 indicates that Grace estimates that the older "post-peak" fields are declining somewhere between 1% and 5% per year. The IEA's decline rate of 3% lies at the midpoint of this range.

A review of Russia's oil fields reveals a simple fact — there are lots of them. The Table 1 data is by no means complete and is not meant to be. Both the IEA and the EIA mention a number of new projects — not always the same ones — that do not appear there. Examining Russian oil company E&P data provides an excellent way to get a handle on future production in the Federation. The survey that follows is not comprehensive, but it provides enough information to allow an evaluation of Russia's oil future.

Rosneft is likely Russia's largest oil company now as measured by annual production, given its continuing takeover of Yukos' assets. Output in 2006 "increased by 7.8% to 582.7 million barrels [1.6 million daily] from 540.4 million barrels [1.48 daily] in 2005. Primary growth drivers were Yuganskneftegaz and Severnaya Neft." Yuganskneftegaz is Rosneft's mainstay development, and includes the Priobskoye, Mamontovskoye, Malobalykskoye and Prirazlomnoye fields, which together make up 80% of reserves there. Prirazlomnoye, along with the Priobskoye field listed by Grace, are cited by both the EIA and IEA as sources of growth. Rosneft states the remaining proved reserves at Yuganskneftegaz as 10.924 billion barrels. The Severnaya Neft development is very small in comparison. Preliminary numbers for the first half of 2007 indicate that Rosneft has increased production to 1.849 million b/d, a 14.6 increase over 2006.

Rosneft is developing the East Siberian Vankor field, which has stated proved SPE reserves of 0.946 billion barrels. The first commercial oil flows are scheduled for 2008, but that date seems wildly optimistic. This project is supposed to make Transneft's Siberian Pacific Pipeline viable, but "plans to build an oil pipeline to the Pacific coast will most likely remain on hold until at least 2015, waiting for the development of east Siberian fields," according to Deputy Industry and Energy Minister Andrei Dementyev. This is a chicken and egg problem, so stay tuned. Rosneft also has shares in Sakhalin stage I and is developing stage III with China's Sinopec. Production at Sakhalin was 0.274 million b/d in the first half of 2007, and is scheduled to increase to 0.420 million b/d by 2010 (*St. Petersburg Times*, August 10, 2007). It is reasonable to expect more growth from Rosneft in the near term.

The LUKOIL Group produced 1.84 million b/d in Russia during 2006 if one includes all affiliate partial shares. This output was 3.7% higher than in 2005, and 76% higher than 2004. LUKOIL, along with its partner ConocoPhillips (30%), expects to get an additional 200 thousand b/d from expansion of its Timan-Pechora developments in the 2010-2011 period. They are currently producing 279 thousand barrels a day in the region. Both the EIA and IEA cite this development as a source of continuing Russian production growth. LUKOIL's 2006 discovery of the Filanovsky field in the Russian sector of the North Caspian, which contains an estimated 600 million barrels of proved and probable oil reserves, will likely add to the company's production in the next decade. Insufficient information is available to evaluate the longer term outlook for LUKOIL's existing production base, but the company's output is still increasing.

Unlike political favorite Rosneft, TNK-BP and Tafneft have the hard job of maintaining and expanding production in Russia's oldest oil-producing basins. Tatneft operates the aging giant Romashkino in Tartarstan along with some other smaller old fields. Accordingly, their report reveals that "due to the relative maturity of the Company's main producing fields, approximately 44.3% (11.3 million tons) of all crude oil was produced using various enhanced recovery techniques." Nearly flat yearly production stood at 0.514 million b/d in 2006, with an unknown proportion of that coming from Romashkino, which Grace lists as producing 0.295 million b/d in 2004. Geology is the implacable foe in Tartarstan — time is not on Tafneft's side.

The production picture is more complicated at TNK-BP. This joint venture operates in Western Siberia, Russia's most mature oil basin. TNK-BP's crude oil output is decreasing according to the company's data. Production stood at 1.419 million b/d in June, 2007. Average daily production was 1.501 million b/d in 2006 but was already below that level in the final 3 months of that year. Output was 1.569 million b/d in 2005. Gas condensate production is also down in 2007. Although their production is not falling off a cliff, TNK-BP is not meeting the goal stated in its 2006 annual report.

We expect that production will be broadly flat through to 2009, but will grow thereafter due to the development of a number of greenfield [new] projects. The Company continues to focus on efficient growth of production volumes at our mature (brownfield) oil fields located largely in Western Siberia.

Grace's data indicates that Samotlor — one of the world's great oil fields, now considerably past its prime — was still producing 0.974 million b/d in 2004. TNK-BP operates the field through two of its subsidiaries, Samotlorneftegaz and TNKNiznevartovsk. Adding these together, the data indicates that Samotlor's production was only 0. 628 million b/d in 2006, which was about 40% of the company's total output. The field has very high water cuts. TNK-BP's 2007 brochure reveals that the number of horizontal wells and sidetracks rose considerably after 2003. They are now drilling multilateral wells to maintain production levels at Samotlor and elsewhere in Western Siberia. After 2009, TNK-BP expects their new "greenfield" developments to boost production. TNK-BP hopes the largest of these, Uvat, will produce 200 thousand b/d by 2020, but the project will only break even at $40/barrel (*Reuters*, June 4, 2007).

Where is Russian oil production headed? Russia's "post-peak" fields, which accounted for 2.4 million b/d in 2004, are mostly depleted. Samotlor is in steep decline. As the old production base erodes, new oil from Sakhalin, Yuganskneftegaz, Timan-Pechora, and elsewhere will offset declines and stimulate modest growth in the near term. The IEA's choice of a 3% baseline decline rate seems generous, however. Most of Russia's oil production still comes from its most mature basins, West Siberia and the Volga/Urals. Russia's oil companies must deal with onerous taxation just as inflation eats into their E&P budgets. It is very expensive to manage highly depleted fields. Challenging new projects like Vankor or Uvat come with steep price tags, and will likely face delays. Prospects at Sakhalin (phases III and IV) remain bright, but it is too early to tell how new discoveries like Filanovsky will turn out.

It is uncertain whether Russia will ever see 10.6 million barrels per day This number appears to be an upper bound on Russia's post-Soviet production peak. Wherever production crests, it is not obvious how production will be sustained at that level thereafter. The only sure thing is that Russia's production peak or plateau is now on the horizon. The end of growth in Russia's oil production is an event of great historical significance. The world should take note, and prepare for the consequences.

1. Conversions here are 7.3 barrels per standard ton, or 7.48 barrels per metric ton, if these units are known. The former is the default.

2. If the term "peak" refers in this context to the high point of oil production — over 12.5 million b/d — in the former Soviet Union during the late 1980's, then the usage is confusing. The term "pre-peak" should be "post-peak" and vice versa. The author has not read Grace's book.

Article found at : *http://www.energybulletin.net/newswire.php?id=33560*

Original article : *http://www.aspo-usa.com/index.php?option=com_content&task=view&id*

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Why 'Peak Oil' May Soon Pique Your Interest — World oil production peaked in 2005, says one expert, and that presents serious problems in the future, by David R. Francis — August 6, 2007*, The Christian Science Monitor*

Do a Google search of the Web on "global warming" and it calls up more than 80 million references. Search for "peak oil" and the number exceeds 10 million… In two years or so, world concern over crude oil supplies should be so great that a Google search on that subject probably will top that of global warming, predicts Matthew Simmons, chairman of Houston-based Simmons & Company International, an investment banking firm for the energy industry.

Peak oil refers to the time when production of crude oil in the world (or in a country or in an oil field) reaches its peak and starts to slide. It doesn't mean the world has run out of oil — only that the supply of oil isn't rising to meet growing demand. That change could be reflected in even higher prices, if the demand for oil doesn't stall or fall. Last Tuesday, the price of oil futures on the New York Mercantile Exchange set a record, rising as high as $78.40. That exceeded the previous high of $77.03 set in July 2006 at the onset of Israel's war in Lebanon.

The world output of oil actually already peaked in May 2005 at 74.2 million barrels a day, says Mr. Simmons. Since then, production has fallen about 1 million barrels a day (MB/D). If that trend continues, the results for the world economy will be "so real, so devastating" that peak oil concerns will overwhelm slower-moving global warming in grabbing world attention… That's because today's civilization hangs heavily on an adequate supply of oil; for instance, it fuels most vehicles, heats many homes and businesses, and is used in many chemicals and plastics. Oil and natural gas now meet some 60 percent of the world's primary energy needs. Oil shortages, warns Simmons, could lead to war.

Dr. Fadhil Chalabi, executive director of the Centre for Global Energy Studies in London, isn't so pessimistic. He notes that with higher prices, the demand for oil has started to fall, at least in the 30 industrial nations belonging to the Paris-based Organization for Economic Cooperation and Development. Since 2006, their demand has dropped by about 400,000 barrels a day, and the demand for crude in bustling and populous China and India rose only 0.7 percent last year… His research institute forecasts world demand will rise "not more than 1 percent a year." Other researchers predict 1.4 to 1.5 percent a year, a significant difference… Mr. Chalabi says forecasts for the world oil industry cannot be relied on, having proved wrong in the past. Today's forecasts do not fully take into account the impact higher prices have in reducing demand and encouraging alternative energy sources, he adds.

However, concern over the world's oil supply is mounting. Last month, the International Energy Agency (IEA) issued a report warning that world oil demand will rise faster than previously expected. The result could be a supply crunch — "extremely tight," one IEA economist told the BBC. The report sees world oil demand soaring 2.2 percent a year to 95.8 MB/D by 2012. That's up from the 2 percent annual growth rate it forecast in February.

The Paris-based IEA advises 26 industrial nations, and, in Simmons's view, it now has a more realistic chief economist, Dr. Fatih Birol; so, the agency, Simmons says, is no longer "a cheerleader for cheap oil," always saying crude oil supplies are so large that oil prices will surely fall.

In July, the National Petroleum Council, a federal advisory group representing the oil industry, published a 476-page study titled "Facing the Hard Truths About Energy." Simmons, one of 350 participants who prepared the study, holds that its wording is not stern enough considering the statistics on the oil demand/supply situation it includes. The study states, "The world is not running out of energy resources, but there are accumulating risks to continuing expansion of oil and natural gas production from the conventional sources relied upon historically." Simmons uses such terms as "hogwash" and "junk report" in describing the study.

For years, many in the oil industry viewed the peak oil forecasts by Simmons as odd. Now his position has a lot of company. Several websites publish sophisticated material on the issue. There's the Oil Drum (www.theoildrum.com), featuring "Prof. Goose" and "Gail the Actuary." Those pseudonyms hide a full professor at Colorado State University and an actuary in an Atlanta suburb. There's also the Energy Bulletin (www.energybulletin.net). The site's coeditor, Bart Anderson, says it receives 11,000 visits a day. Peak oil enthusiasts, he says, have now divided into a majority seeing life after an oil crunch and those he calls "doomers."

In Britain, Douglas Low, director of the Oil Depletion Analysis Centre (www.odac-info.org), foresees a "crisis coming up" with a real shortage of oil. In June, he notes, the world used 1.5 MB/D more crude than it produced. He expects much higher oil prices in the future… “It’s not a very happy message,” he says. “A lot of people want to slip it under the carpet.”

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American Civil Engineers brings out the Report Card for America. In 2005, professionals gave the infrastructure a “D” overall. http://www.asce.org/reportcard/2005/page.cfm?id=103. In the category for the 590,750 bridges, it sees 27.1% (2003) as structurally deficient or functionally obsolete. The cost to eliminate all bridge deficiencies will cost $9.4 billion annually over 20 years! — right across the board, a total investment need of $1.6 trillion over 5 years. About 2/3 of this is available in current spending budgets at local and federal level. If it is being underfunded in the boom times, what will happen in a downturn? **In a Price System, the health of money is more important than you or I.**

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This issue of Technocracy Trendevents is perhaps the ideal vehicle for this announcement: The seventh printing of TECHNOCRACY — TECHNOLOGICAL CONTINENTAL DESIGN **(TTCD — Functional Governance for North America)** as a 72 page-full color spiral bound book is now available. Technocrat Bill DesJardins began this project and has had it available on his web page as a project awaiting completion. Technocracy’s Continental Headquarters assigned staff members to bring this original rough draft up to professional standards. With the great due diligence of our volunteer Technocracy Staff and Trendevents editor Margaret Mathers, we have achieved our goal.

To explain the purpose for this book, which we call the **TTCD**, we present these few words from the Introduction:

“This book is by no means an exhaustive examination of the topic of Technocracy. Technocracy, as a study, encompasses nearly all human fields of study and endeavor, from hard sciences such as physics, chemistry, biology, and geology, applied sciences such as engineering, medicine, and architecture, to the humanities, psychology, and sociology, as well as other fields such as economics. To learn all the data and subsequent conclusions that Technocracy has researched in its time would be impossible for any single human being to accomplish in one lifetime.

“It is Technocracy’s mandate, however, to educate the citizens of North America about its research and conclusions to the best of its ability to do so; therefore, we provide you with many avenues in which to learn about Technocracy. The primary and best way to do this is to take Technocracy’s Study Course. This is a 22-lesson plan covering the basics of all the science and engineering and subsequent social design, so that the student has a sufficient understanding of Technocracy to be able to relate to others in turn. This is not as dry as it may seem, given the participatory nature of the Study Course. It can be as entertaining as it is informative.

“For some, however, access to a Study Course is unavailable or there is not one scheduled when the prospective students are available from their duties with work, school, or family. There are also those who would prefer, for their own reasons, not to commit to the 22-lesson plan of the Study Course. For these people we offer this book, **TTCD**, as a brief overview of the topics discussed in the Technocracy Study Course. It is not a replacement and will undoubtedly leave you with many questions yet unanswered, but it is a start. Hopefully, it will provoke you into investigating Technocracy’s analysis and synthesis in more depth, so that you may be certain for yourself of the validity of Technocracy’s conclusions.”

For a limited time we are pricing the **TTCD** at $12.00 U.S. per copy, which includes postage. Please enclose money order or check with your order to:

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