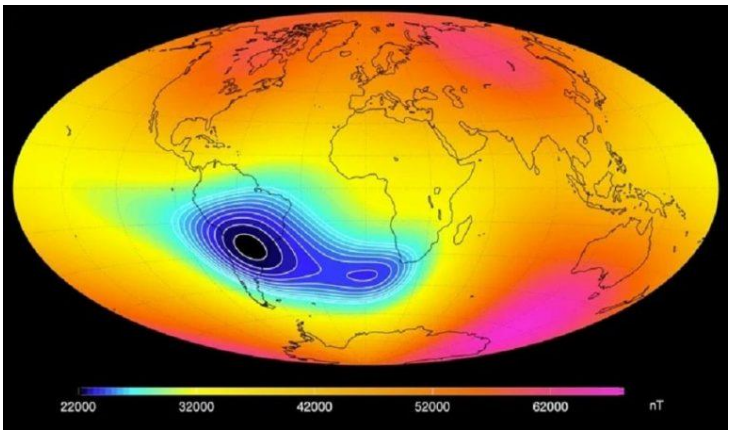
South Atlantic Magnetic Anomaly



NOM PRENOM	DATE	ACTION
Michel L Friedman (DESTOM Chartered 67/11)	2020/12/15	CREATION Rev. _ 00
Michel L Friedman (DESTOM Chartered 67/11)	2022/05/27	IMPROVEMENT Rev. _ 01

Registered Office
rss-nmr@fands-llc.biz
Land line +17863528843
Naaman's building suite 206
3501 silverside road
Wilmington Deleware 19810 USA

Acronyms

- **RSS** is the process of resonance of space images in a nuclear reactor,
- **NMR** is the resonance process in the oil field

0-Introduction

All part of this article that has appeared in the La Paz press
https://www.paginasiete.bo/economia/2020/12/10/de-los-74-pozos-explorados- desde-2006-ninguno-tuvo-exito-277564.html?__twitter_impression=true

- Reading the article on page seven, a main question comes to mind : how in 16 years with more than 74 wells drilled have they not made a discovery? That's out of any world statistics and for reference the success rate of finding hydrocarbon is one to three. The reference is easy and can be found *https://www.planete-energies.com/en/medias/close/exploration-multi-stage-process*

- ***Costs Borne by the Companies*** *"It costs at least €3 million to €4 million to drill an exploration well onshore, and ten times more offshore. The average success rate es just one in three ."*
- I don't know who the seismic operators were, but they are qualified and I don't understand why a theoretical result given as positive by seismic in the field does not even give a positive result after drilling a well, that in 16 years and 74 wells?
- I don't think it's bad luck, I don't think it's the incompetence of the seismic and drilling companies, or the lack of project management by the oil company teams that manage said project.
- I have been thinking about this story of negative wells. That is why, while verifying data with the European space agency, I found the **South Atlantic Magnetic Anomaly** (where Bolivia is the world epicenter). The anomaly is the fact that the earth's magnetic field has a particular value in this region of the earth's surface, that is, the southern part of the South American continent and southern Africa.
- It is a typical condition of Bolivia, very little they know about magnetic fields and AMAS. I have been fortunate to have as a Geology/Geophysics Professor in my engineering school, a researcher from the Globe Geophysics Institute. He told us about this phenomenon in the 70s, about tectonics, about 3D, about possible oil reservoirs beneath the saline geological layers in French Guiana.
- The South Atlantic (magnetic) anomaly is well known, it would be interesting to know if this phenomenon can influence the seismic before the exploration well. Investigating more about the consequences of the South Atlantic (magnetic) anomaly, this phenomenon is harmful to all satellite equipment that passes over this area. https://www.businessinsider.fr/la-nasa-surveille-une-anomalie-dans-le-champ-magnetique-terrestre-qui-menace-les-satellites-et-liss-185279
- Turning off the instruments on board the satellites means that the seismic devices on the ground receive a lot of interference and it may be that their data is not reliable. It is a hypothesis. Another source https://www.lavenir.net/cnt/dmf20200529_01478906/assiste-t-on-aux-premiers-signes-d-un-phenomene-rare-que-la-terre-na-plus-connu-depuis- 700-000-ans

1. The AMAS or South Atlantic Magnetic Anomaly

1.1. Definition

The South Atlantic Anomaly refers to a region of the world in which the intensity of the Earth's magnetic field is significantly reduced compared to its average intensity over the rest of the globe. The processes that caused this decrease in intensity remain unknown. However, geophysicists have been tracking its evolution for several decades, and recent satellite data has shown that it is about to split in two. (South America and Southern Africa)

New satellite data from the European Space Agency (ESA) reveals that the mysterious anomaly **weakening Earth's magnetic field continues to evolve** , and the most recent observations show that several of these phenomena could appear simultaneously. The South Atlantic anomaly is a large area of reduced magnetic intensity in the Earth's magnetic field, extending from South America to southwestern Africa. And in Namibia where I have drilled 4 wells and in total there were more than 20 offshore exploratory wells, in truth oil was never found and it is the same situation as Bolivia.

Since our planet's magnetic field acts as a kind of shield—protecting Earth from solar winds and cosmic radiation, **as well as determining the location of the magnetic poles** —any reduction in its intensity is an important event that we must Watch closely as these changes could ultimately have major implications for our planet and our oil research activities since we use GPS.

1.2. Explanation of the phenomenon

This anomaly is explained by the fact that the inner part of the Van Allen belt is the closest to the Earth's surface in this region. The lobes of the Van Allen belt are arranged symmetrically with respect to the Earth's magnetic axis, which is offset about 11 degrees and 450 kilometers from the Earth's axis of rotation. Because of this change in both angle and position, the Van Allen belt is closest to Earth in the southern Atlantic and farthest in the northern Pacific1. For a given altitude, the radiation level from space is higher in the South Atlantic than in other parts of the world2.

1.3. Consequences

Earth's total magnetic field. AMAS is represented by the blue and dark part over Brazil. Field lines having at this point approximately the shape of a duck's head, the area is also known, in Spanish-speaking countries, as El Pato.

Animation of secular variation in geomagnetic total intensity for the last 400 years.

http://wdc.kugi.kyoto-u.ac.jp/igrf/anime/index.html

1.3.1. Aerospace

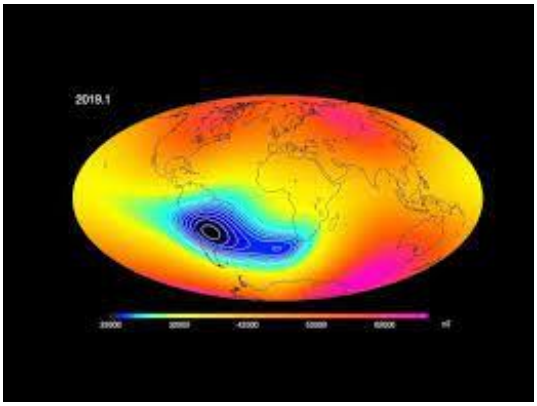
AMAS can disrupt satellites and other spacecraft, including those orbiting at an altitude of a few hundred kilometers with an inclination between 35° and 60°. Satellites following these orbits regularly pass through AMAS, exposing themselves to high levels of radiation for several minutes. The International Space Station, whose inclination is 51.6°, has received a special coating to withstand this radiation. Several orbiting satellites, including the Hubble Space Telescope and the AMS-02 cosmic ray detector, do not make any observations when passing over this region, as the risk of damage is too great. AMAS is moving west by

about 0.3 degrees per year. This value is very close to the difference in rotation speed between the core and the surface of the Earth, between 0.3 and 0.5° per year.

1.3.2. Southern Brazil

Given the properties of AMAS, induced geomagnetic currents can be produced in southern Brazil, through large metallic infrastructures such as railways, high-power power lines, the water distribution network or other large mechanical structures. In the event of a large geomagnetic storm, these currents can damage structures. Several research institutes around the world are developing models of the ionosphere and magnetosphere with the aim of predicting the global conductivity and magnetic field of the Earth. The necessary data can be acquired by satellite measurement to alert local authorities in time.

In the south of Brazil, the city of Paula Freitas in the state of Paraná has a geomagnetism laboratory that is part of the Institute of Aeronautics and Space (pt) (IAE), in connection with the Gera Command of Aerospace Technology (pt) (CTA), on the site of the Mayor Edsel de Freitas Coutinho Geophysical Research Campus, UNIBEM - IAE Agreement (pt). The main role of this institute is the study of AMAS and its effects on a regional and global level. Currently (2007) it is under the control of the Integrated 'Spiritist' Faculties (pt) (UNIBEM). The research center is located very close to the epicenter of the anomaly.



1.3.3. The Earth's magnetic field: a downward trend

For the moment, there is nothing to worry about. ESA notes that the most important effects are largely limited to technical malfunctions on board satellites and spacecraft, which may be exposed to increased numbers of charged particles in low Earth orbit as they pass through the anomaly. from the South Atlantic, towards the sky over South America and the **South Atlantic Ocean.**

However, the magnitude of the anomaly should not be ignored. Over the past two centuries, Earth's magnetic field has lost about 9% of its strength on average, according to ESA, combined with a decrease in the minimum field strength in the South Atlantic anomaly, of about 24,000 nano Teslas. to 22,000 nano teslas in the last 50 years.

This video http://wdc.kugi.kyoto-u.ac.jp/igrf/anime/index.html shows the evolution of the Atlantic Anomaly over several centuries. Follow the purple/fuchsia to see the evolution over time, If you want to have a panel for each century you can:

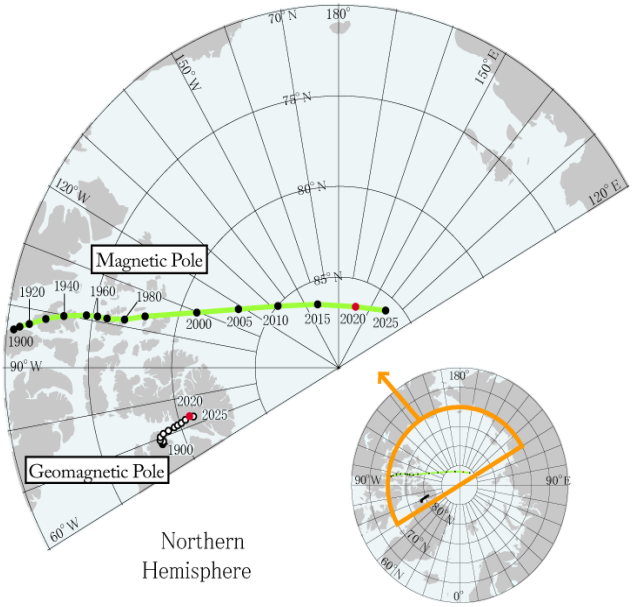
The exact reason why this is happening remains a mystery.
One hypothesis would be that the Earth's magnetic field is generated by electrical currents produced by a swirling mass of liquid iron in the outer core of our planet, but, although this phenomenon seems stable at a given moment, on large time scales, it has never it really is.

Studies have shown that the Earth's magnetic field is constantly in a state of flux, and every few hundred thousand years, **the Earth's magnetic field changes, with the north and south magnetic poles changing places.**

1.4 Are the magnetic poles moving faster and faster, towards an inversion of the Earth's magnetic field?

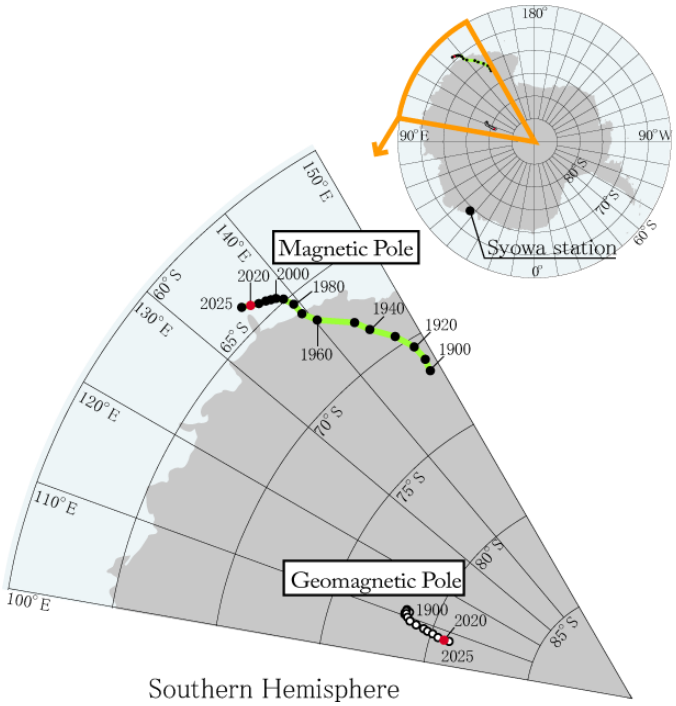
1.4.1. North magnetic pole

- For the last thirty years or so, the North Magnetic Pole has been moving faster and faster, moving out of Canada toward Siberia.
- This sudden change could herald the reversal of the magnetic poles as Earth's magnetic field continues to weaken.
- In any case, scientists must increasingly revise the Earth's magnetic model that serves as the basis for modern navigation systems.
- First measured in 1831 by explorer James Clark Ross in the Canadian Arctic, the magnetic field is unstable on the geologic time scale.
- In fact, one of its most surprising features, revealed by paleomagnetic studies, is the random reversal of the magnetic poles.
- In other words, magnetic north and south, which are respectively close to geographic north and south, reverse at a chaotic rate averaging about four events per million years, or once every 250,000 years.



.

1.4.2. South magnetic pole



1.4.3. The consequences of a magnetic field reversal

The Earth's magnetic field has its origin in the slow cooling of the interior of the outer core of our planet where there is an ocean of superheated and swirling liquid iron that creates convection movements, between 2,900 km and 5,150 kilometers under our feet. Other factors are involved such as magnetized rocks in the Earth's crust and the flow of the oceans, particularly through the tides, whether on the surface or in the depths.

Convection movements in the outer core generate a dynamo effect called geodesic, which converts a fraction of the energy released by cooling into electromagnetic energy. This magnetic field forms the magnetosphere between 800 and 1,000 km above sea level. It acts as a shield that protects life on Earth from the excesses of the solar wind. The last reversal of the magnetic field occurred about 773,000 years ago. If these investments have not been accompanied, a priori, by major biological crises, a new inclination of the magnetic field would be a real challenge or even a catastrophe for our technology-dependent civilization. In fact, electronic, computer and navigation systems would be completely disrupted/disoriented and therefore the entire world economy and transportation.

a. These are some consequences:

- interruptions in telecommunications systems: satellites, submarine cables...
- degradation or interruption of satellite positioning services, for example, GPS or Galileo;
- the increase in radiation received by airplane passengers and astronauts;
- induced currents in pipes, accelerating their wear;
- parasitic currents in electrical networks, which can cause blackouts in large areas.

- The magnetic north pole is moving faster and faster

b. Facts

- In the mid-1990s, the North Magnetic Pole was moving faster and faster, from about 15 kilometers to about 55 kilometers per year.
- The South Magnetic Pole is constantly moving rapidly. See movement map

Hypotheses are presented: geomagnetic pulses, like the one in 2016, that could be attributed to "hydromagnetic" waves from the depths of the heart of our planet and the presence of a high-speed jet of liquid iron under Canada.

A study led by Phil Livermore, from the University of Leeds (England), published in the journal Nature Geoscience in early May 2020, puts forward a new hypothesis. The shift of the North Magnetic Pole could be explained by a "confrontation" between two areas of the Earth's magnetic field, one under Canada and the other under Siberia. "We discovered that the position of the North Magnetic Pole is controlled by two parcels of magnetic field. They act as a tug-of-war effect that controls the location of the pole," Livermore told the BBC.
Thus, according to researchers, the Siberian magnetic zone has suddenly become more powerful than the Canadian zone, attracting the North Pole, which is strongly changing from its historical position in Canada.

2. Why GPS and compasses are losing their way

Variations in the Earth's magnetic field require recalibration of GPS and compasses .

If we take regular measurements in the same place: magnetic north or south moves. Even faster and faster. A few decades ago, it was anchored in the Arctic, in northern Canada. Since then, it descends towards Siberia. Initially at an average of 10 kilometers per year; but the pace has accelerated, to exceed 55 kilometers per year. Should we be worried? Is there a risk of our navigation instruments failing?

This phenomenon was anticipated by scientists. Every five years, ***the creators of the World Magnetic Model (WWM) which is a large-scale representation of the magnetic field, publish a set of recommendations for recalibrating GPS, compasses and mapping systems. And for cause. True north, the North Pole, remains fixed. On the other hand, magnetic north, captured by a compass needle, can move.***

That is why the WMM model was developed. In principle, the organization reviews it every five years, from observation stations located around the world. But, given the acceleration of drift, a new model was released beforehand to limit changes with measuring instruments. Scientists now predict a slight slowdown. From 55 kilometers a year, we should go down to 40,

However, if this drift continues, the poles could end up reversing. The phenomenon has already occurred several times in the history of the planet. During this transition, the Earth's magnetic field loses its intensity and dangerously exposes living beings to solar radiation. However, let us be sure that such a change would take between five thousand and ten thousand years. Therefore, it is unlikely that a human civilization would experience it.

3. Legitimate questions

Magnetic and electromagnetic methods are the basis of modern seismic and the questions are more of a QA/QC nature.

1. "This phenomenon was integrated by the seismic companies at the time of beginning to recover the data during the data collection phase, that is, tuning the devices for a total station during the topography phase."

I do not believe that, if 74 wells turn out negative in 16 years, that it was caused by a problem of bad luck or the incapacity of the people involved in these exploration works.

From my point of view, there is something more global, it is a point that I knew from my specialization in deep water management and search more than 35 years ago, but I do not have the authority or knowledge to affirm that in the oil field and with seismic service companies. I don't know if at the QC/QA level, but the tools exist to make corrections.

3.1. Japan

A. World Data Center for Geomagnetism, Kyoto http://wdc.kugi.kyoto-u.ac.jp/index.html
B. What is the Earth's magnetic field? http://wdc.kugi.kyoto-u.ac.jp/wdc/Sec2.html
C. Model field at a point by IGRF http://wdc.kugi.kyoto-u.ac.jp/igrf/point/index.html

3.2. USA

A. general information https://www.ngdc.noaa.gov/geomag/WMM/back.shtml
B. online calculators https://www.ngdc.noaa.gov/geomag/WMM/calculators.shtml
C. software https://www.ngdc.noaa.gov/geomag/WMM/soft.shtml

3.3. What risks? Without mentioning the “extreme” case of a pole reversal, what are the risks of a weakening of the Earth's magnetic field today?

- “At surface level, the South Atlantic anomaly presents no reason for alarm, responds the European Space Agency. However, satellites and other spacecraft flying in the region are more likely to experience technical glitches (use Microsoft Edge to translate)

- https://www.aviso.altimetry.fr/fr/actualites/image-du-mois/2007/oct-2007-lanomalie-de-latlantique-sud-vue-par-oris.html#:~:text=L'anomalie%20de%20l'Atlantique%20Sud%20est%20un%20ph%C3%A9nom%C3%A8ne%20qui,plus%20proche%20de%20la%20surface .
- https://cnrtl.fr/definition/tellurique
- https://www.futura-sciences.com/sciences/actualites/observation-terre-anomalie-magnetique-atlantique-sud-annonce-t-elle-inversion-magnetique-imminente-81179/
- https://cnes.fr/fr/web/CNES-fr/5709-corot-cerne-les-contours-de-lanomalie-de-latlantique-sud.php
- https://coriolis.ugar.ca/lanomalie-magnetique-de-latlantique-sud/
- https://www.fredzone.org/une-theorie-au-sujet-de-lanomalie-de-latlantique-sud-988

4. The RSS-NMR

That is why the RSS-NMR methodology would be interesting to try “ the remote method for detecting hydrocarbons directly (RSS)”. We trigger a resonance (a direct response to what we are looking for) of the

substance we are looking for in the reactor space images (RSS). We get the images from NASA or Roscosmos .

In other words , it is the only way to do a seismic survey in Bolivia for the simple fact that magnetic anomalies do not affect us because we work remotely.

4.1.How does RSS-NMR technology work?

4.1.1. RSS-NMR technical explanations

"What is the difference between the existing remote methods in various companies and our remote method (Stage1 Diagnostics)"?

For comparison, let's take the seismic technology used by all oil exploration companies. Seismic machines generate a high-power signal that is directed underground. Firstly, this powerful signal does not carry any information and secondly, it dissipates in all directions and therefore must be very powerful to reach the depths. When it reaches the limit of the two underground media, it is reflected and collected by receptors on the surface. (The faceless sign does not penetrate into the substance, it is an anomaly). And then a long interpretation of the data is necessary. We talk to many interpreters who have different opinions on the same object. That is, some kind of anomaly is revealed. Which may or may not be a deposit. Only drilling can confirm the presence of the deposit. Statistics say that only 3 or 4 wells hit the target. The efficiency of seismic is not higher than 30-35%. The main property of seismic is reflection.

4.1.2. How does RSS-NMR technology work?

Nuclear magnetic resonance (NMR) is the phenomenon in which the nuclei of a static magnetic field are disturbed by a weak oscillating magnetic field; They respond by producing an electromagnetic signal at a particular frequency of their core's magnetic field. A key feature of NMR is that the resonance frequency of a particular simple substance is directly proportional to the strength of the applied magnetic field. It is this characteristic that is exploited in imaging techniques; If a sample is placed in a magnetic field, the resonance frequencies of the nuclei in the sample depend on where in the field they are located. Radiofrequency magnetic fields penetrate both soft and hard rocks, allowing higher resolution anomalies to be mapped and can be easily used with a ship, plane, helicopter or truck for exploration.

4.2. Various stages

4.2.1. Level 1

Special processing and interpretation of analog satellite images. The stage includes the following:

- Processing of image material with ingenious nano gelees and solutions to amplify and highlight spectral anomalies associated with oil accumulations/mineral deposits
- Improved image processing in a small-scale nuclear reactor,
- Plotting preliminary limits of hydrocarbon accumulation/mineral deposits on the map of the area of interest.

4.2.2. Stage 2

The resonant frequencies of the atoms of the reference molecule are imposed/modulated on the carrier frequency by a high frequency generator. High-frequency electromagnetic fields, characteristic of the reference sample elements, are induced above the sample buildup by their resonant frequencies. Each characteristic electromagnetic field is recorded sequentially by a sensitive receiving device tuned to record

the resonant frequencies of the reference sample atoms, ensuring plausible identification of oil accumulations/mineral deposits.

4.2.3 Stage 3
Compilation of results and writing of report

4.3. Benefits of the NMR approach

• Substantial increase in the chances of success,
• Reduce risks and uncertainties,
• Highly profitable, and very inexpensive
• Focus on exploration acreage only, for prospect delineation and drilling/trenching, with specific seismic, if necessary

Using ingenious remote sensing expertise and corroborating field work derived from nuclear magnetic resonance (NMR) theory, commercially relevant anomalies are identified, delineated and geologically verified. Beneficial prior knowledge is provided on the economic viability of the cultivated area; also, recommendation on the best area for specific seismic (if pursued) or drilling.
Applying three integrated disciplines of proprietary remote sensing insight, scientifically vindicated NMR field work and the latest G&G authentication of findings, it drives a powerful and innovative toolset that is as disruptive as it is efficient.

4.4. The integrated exploration approach allows:

or substantially increase the chances of success,
o reduce the cost of exploration by acquiring less seismic data than normal and greater chances of no dry holes,
o identify areas within the exploration surface where detailed seismic or drilling/trenching should be planned,
o estimate the resources and their values to make the decision to proceed with the cultivated area or give up, etc.,
o prioritize potential customers by their COS, estimated resources, economics, etc., at the beginning of the field's useful life,
o outline a realistic exploration program

4.5. How can you use this tool?

4.5.1 New fields

YO. rapid exploration of large areas to delimit areas of interest (where a seismic could be useful), to reduce the cost of a systematic seismic on 100% of the new field when only 15% are really with a probability of discovering a reservoir.
II. rapid exploration of the blocks included in an auction or licensing cycle to determine
• if some of the blocks are of interest
• whether the cost of traditional seismic exploration is acceptable

4.5.2. old fields

I. In the event of a merger or acquisition of another block or of an entire E&P entity, it is the only way to determine the real potential of the assets to be purchased.

II. Re-exploring mature fields is of great interest because this action makes it possible to avoid a new project cycle. The truth is that starting a Greenfields or new project means that it will generate extraordinary expenses for E&P, a lot of time for qualified personnel, a lot of paperwork.

If we must compare:

- A Greenfields project is spending a lot of human energy and a lot of money, without the certainty of discovering something.
- Refurbishing or re-exploring a mature field is an easier way to increase its production . In this case it is only a modification of the production network.

4.6 Certifications of oil and gas reserves

4.6.1. Reserve definitions

- ## Proven reservations

Proven reserves are those reserves that are stated to have reasonable certainty (typically at least 90% certainty) of being extractable under existing economic and political conditions, with existing technology. Industry specialists call it "P90" (that is, there is a 90% certainty that it is achievable). Proven reserves in the industry are called "1P".

The proven reserves are subdivided into **"proven developed"** (PD from the English " proven "). developed ") and **"proven undeveloped"** (PUD from the English " proven undeveloped ") .

A. **PD** reserves are reserves that can be extracted from existing wells and drillings, or from additional reservoirs with minimal additional investments that are taken on the Opex .

B. **PUD** reserves require additional capital investments (for example, drilling new wells) to extract the oil. These investments are decided and are part of the Capex .

- ## Unproven reservations

Unproven reserves are based on geological and/or engineering data similar to those used in proven reserve estimates, but technical, contractual or regulatory uncertainties prevent such reserves from being classified as proven. Unproven reserves may be used internally by oil companies and government agencies for future planning purposes, but are not routinely compiled.

They are subclassified into probable and possible.

A. The probable reserves

They are attributed to known accumulations and claim a 50% certainty level of recovery. Industry specialists refer to these as "P50" (i.e. they are 50% certain to be produced). The sum of proven plus probable reserves is also known in the industry as "2P" (proven plus probable).

B. Possible reservations

They are those known accumulations of oil from which there is less certainty that they are extractable than probable reserves. This term is often used for reserves that are estimated to have at least 10% certainty of being extractable ("P10").

Criteria for classifying reserves as possible include various interpretations of the geology,

- non-extractable reserves at current market prices, uncertainty regarding reserve replacement flows (for example, from adjacent oil areas and this is seen with the RSS-NMR)

- projected reserves based on future recovery methods.

The total volume of the sum of proven, probable and possible reserves is called "3P" (proven plus probable plus possible).

4.6.2. Estimation techniques

The amount of oil in an underground reservoir is called " **oil in place"** (OIP **)** . Only a fraction of this oil can be recovered from a reservoir. This fraction is called ***the "recovery factor."*** The portion that can be recovered is considered a reserve. The portion that is not recoverable is not included unless and until methods are implemented to view and produce it.

- **Volumetric method**

Volumetric methods attempt to determine the amount of oil in the site from estimates of the size of the reservoir and the physical properties of its rocks and fluids. Thanks to RSS-NMR, a 4D image is obtained that allows volumes to be determined.

Thanks to the modeling obtained by RSS-NMR, a recovery factor is defined, based on assumptions and knowledge of oil fields with similar characteristics.

The OIP is multiplied by the recovery factor to finally obtain the size of the reserve. Current recovery factors for oil fields in different parts of the world range between 10 and 60%; some are more than 80%.

This wide variability is largely due to the diversity of the fluid and the characteristics of different geological formations.

The method is most useful early in the life of the reservoir, before it has been significantly exploited.

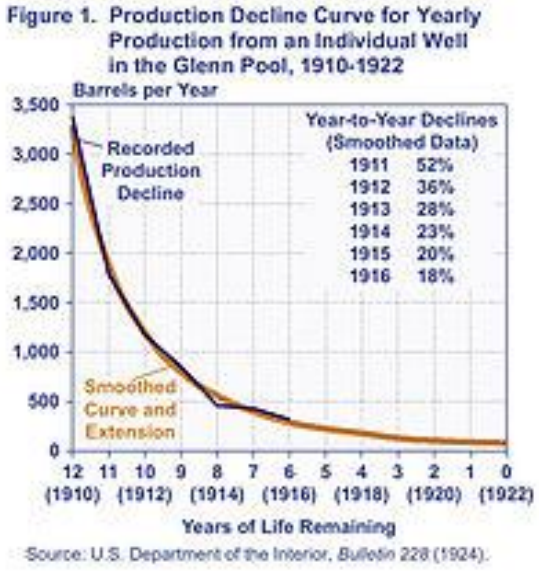


Figure 1. Production Decline Curve for Yearly Production from an Individual Well in the Glenn Pool, 1910-1922

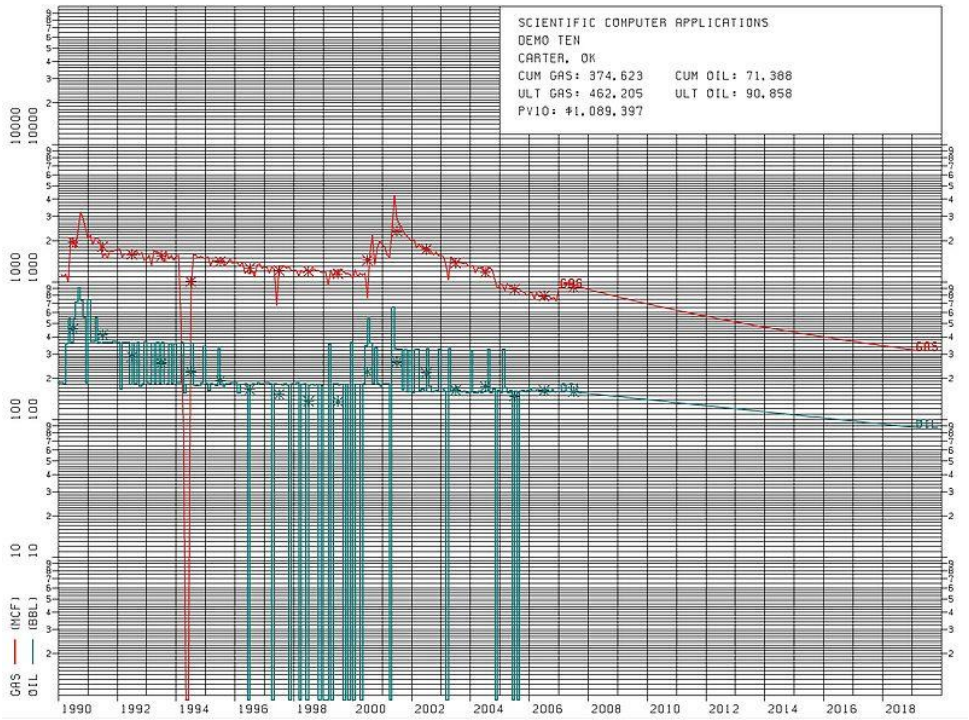
Source: U.S. Department of the Interior, *Bulletin 228* (1924).

Material balance method

The material balance method for an oil field uses an equation relating the volumes of oil, water and gas that have been produced from a reservoir and the change in reservoir pressure to calculate the amount of oil remaining. It is assumed that as fluids are withdrawn from the reservoir, there will be a change in reservoir pressure that depends on the remaining volume of oil and gas.

The method requires extensive pressure-volume-temperature analysis and accurate pressure history of the field. Some production (typically 5% to 10% of final recovery) is required, unless a reliable pressure history can be used from a field with similar rock and fluid characteristics.

Production decline curve method



- Production decline curve generated by analysis software, used in the economic study of oil to estimate the depletion of an oil and gas reservoir.

- The Y axis is a logarithmic scale, indicating the rate of oil depletion (green line) and gas depletion (red line).

- The X axis is a linear scale, which indicates the passage of time in years.

- The red line at the top shows the gas decay curve, which is a descending hyperbolic curve. Gas is measured in MCF (thousands of cubic feet in this case).

- The bottom blue line is the oil decay curve, which is an exponential decaying curve. Oil is measured in BBL (Barrels of Oil).

- The information corresponds to actual sales made, not pumped production. The decreases to zero indicate that there were no sales that month, probably because the well's production was not enough to complete a tank, and therefore the tank truck was not there to collect crude oil.

- The legend at the top right indicates the CUM, which is the total cumulative amount of gas or oil extracted.

- ULT is the projected final recovered value for the well at the end of its useful life. Pv10 is the net present value discounted at a rate of 10% per year, which is the future value of what remains of extractable oil until the end of the remaining lease , calculated for this oil well at $1,089 million USD.

- The production decay curve method uses production data to fit a decay curve and estimate future oil production.

- The three most common shapes of decay curves are exponential, hyperbolic, and harmonic. It is assumed that production will decrease following a smooth curve, and therefore certain reserves must be made for well shutdowns for maintenance and production restrictions.

Note

The curve can be expressed by a mathematical equation or by drawing it on a graph to estimate future production. It has the advantage of (implicitly) including the effects of all reservoir characteristics. For its construction, it is necessary to have enough historical records to have a statistically relevant trend to fit the curve, ideally when production is not limited by regulatory conditions and other exogenous conditions.

4.7. Who uses the reservation certification

4.7.1. Authority or government

The only possibility for a government to control its oil and gas operators is to carry out its own certification of its reserves by experts approved by the NYSE Stock Exchange Commission (SEC). That is why RSS-NMR allows us to quickly give a true image of the reservoir and its contents.

4.7.2 Reserve Certifications for an E&P

A reserves certification is an official document, signed and sealed by a third party, licensed petroleum engineer or geologist, that discloses oil reserves, estimated future production profiles and cash flows established strictly according to criteria. After the Construction study of the reservoir production network, these flows are confirmed.

4.7.2.1. Methodology

A consultant estimates oil reserves through the reserve evaluation process (*4.6.2. Estimation Techniques* **)** . Clients submit independent reserve certifications to exploration and production companies, administrations, governments, including regulatory authorities, as well as banks, law firms, courts, trustees, accountants and arbitrators.

- Uses for Independent Reserve Certifications
- Periodic regulatory filings, initial public offerings
- Presentations to governmental, ministerial organizations and national oil companies
- Commerciality declarations
- Loan agreements, determinations and redeterminations of loan bases because a reserve is an asset
- Possible financial transactions, including acquisitions, divestitures and mergers
- Restructurings, bankruptcies, liquidations
- Tax and estate planning
- Legal presentations, affidavits/exhibits, expert witness testimony
- Redeterminations and unifications
- Give shareholders a better vision of the company
- Support stock market listing to increase the value of E&P

4.8. Russian reservation categories

Due to the events in Europe it is good to understand how reserves are certified in Russia.
For Moscow, reserve categories A, B, and C1 correspond approximately to

- "proven developed in production"
- "proven developed that are not in production",
- "proven not developed"
- the ABC1 designation corresponds to proven reserves.
- The Russian C2 category includes probable and possible reserves.

5. Conclusions

In conclusion, a re-study of the reservoir and thus of the reserves in a brownfield with an RSS-NMR study can be the solution to change the classification of the various reserves and be able to put new assets in

case of loans. This investment makes it possible to finance the physical rehabilitation of the brownfield itself by submitting a complete study to the reservoir certification company .