

The economics of gold

Foreword

Françoise Roure, Conseil Général de l'Économie

1 - Finding gold and operating mines

Techniques of prospecting for gold

Jérémie Melleton, Éric Fournier and Éric Gloaguen, Bureau de Recherches Géologiques et Minières (BRGM)

Gold tends to be associated with iron in minerals. This precious metal is usually present in very weak concentrations (on a ppb-scale) in rocks in the Earth's continental crust. The processes at the origin of the formation of economically feasible ore deposits, which are mainly mined using hydrothermal circulation, sometimes have an enrichment factor of a magnitude of 10,000. It is complicated to classify gold deposits, but the knowledge acquired about the principal categories serves to draw up guidelines for prospecting that take account of geological contexts, alterations or geochemical signatures. Approaches to prospecting rely on geochemistry and geophysics. At present, prospecting activities are concentrated in Canada, Australia, Latin America and Africa.

Techniques and conditions for operating gold mines

Philippe Matheus, Compagnie Minière de Boulanger (CMB)

After placing gold and prospecting activities in a historical context, various techniques used to mine gold are reviewed. The ore-processing methods applicable to gold deposits are presented by concentrating on the operation of gold mines in French Guiana.

Satisfying a gold mine's energy needs: The Essakane mine in Burkina Faso

Christophe Fleurence, vice-president of Business Development Africa, Total Eren

Solar energy has replaced nearly five hundred tonnes of fuel oil per month in the Essakane gold field in Burkina Faso, which, located in a remote area, is not hooked up to the national electricity grid. The mining company, which belongs to the Canadian group IAMGOLD, has opted for an innovative energy supply in the mining industry. To satisfy an average demand for 40 MW of electricity, the mine has formed a partnership with an energy producer. Total Eren and AEMP (Africa Energy Management Platform) have developed Essakane Solar. Total Eren has connected a photovoltaic power station with a production capacity of 15 MW-peak to the thermal power station with a capacity of 57 MW used by the mining company. The total installation now represents the biggest mixed (solar/fuel oil) power station in the world and one of the biggest solar installations in Africa south of the Sahara. How to satisfy a gold mine's energy needs? Herein, a pioneer in renewables makes a few points...

Innovations in Mining Operator Efficiency Through Simulation Based Training Technologies and Processes

Immersive Technologies

Within the often-hazardous mining industry, simulation training has quickly gained recognition as a significant method of increasing site safety and profitability through improved operator skill and knowledge. Simulators provide operators a safe environment to learn and practice their skills; Immersive Technologies' simulators allow the operator to practice for a range of possible emergency situations. Many of these situations are too dangerous, too difficult or too expensive to test in an actual mine.

Immersive Technologies has deployed over 80% of the Advanced Equipment Simulators operating around the world to the broadest range of mining environments. This experience, together with ongoing feedback from customer base and Original Equipment Manufacturer alliance partners, has provided Immersive Technologies with the knowledge necessary to develop the most accurate, reliable and outcome oriented Equipment Simulators.

Immersive Technologies' Equipment Simulators are supported by the industry's most comprehensive range of compatible tools, technologies and professional services. This ensures a solution to meet or exceed your needs can be defined, delivered, implemented and generating operational results quickly and with very low risk.

Financing plans for gold mines: Stages, players and criteria

Sylvain Eckert, Natixis

Since gold-mining plans are, above all, mining plans, they are quite different from other industrial projects. Time passes between the discovery and actual mining of a gold deposit. The plans made pass through stages as various investors intervene, whose quite different expectations for a return on investment are aligned on their ability to back the risks related to the plans. After describing the stages of plans for mining gold, the means of funding them are discussed along with the various investors (stakeholders in equity, venture capital funds, commercial banks, hybrid funds), their ways of intervening and their relation to risk-taking. The criteria are described that these investors use to put up funds during each stage of the plan.

Illegal trade in the gold mined by small-scale producers in sub-Saharan Africa

Victoria Reichel, IMPACT

Despite its importance as a source of income for millions of workers, small-scale gold production in Africa provides very little income to the governments there. The informal nature of artisanal, small-scale production and the highly complex means used to finance mining during the production chain make it very hard to control small-

scale producers and the trade in the gold they mine. The extent of this illegal trade in Africa is discussed. Given the absence of reliable global statistics on this topic, a brief description is made of three West African countries (Mali, Burkina Faso and Ivory Coast) and of the African Great Lakes region in reference to the studies made by IMPACT (formerly Partnership Africa Canada), a Canadian NGO. In these two regions of Africa, the illicit gold trade involves crossborder smuggling: the precious metal is transported illegally out of the producing country toward a neighboring land from which it is “legally” exported as if it came from this second country

2 - The uses of gold in industry

The structure of physical gold markets in 2018

Gaéтан Lefebvre and Mathieu Leguérinel, Bureau de Recherches Géologiques et Minières (BRGM)

Worldwide demand for gold is usually distributed among five major categories: the jewelry business, technological applications, exchange traded funds (ETFs), central banks and the mintage of coins and ingots. The shares of the first two as a part of total demand are relatively stable and, therefore, foreseeable: 55%-60% and 8% respectively. On the contrary, demand in the three other categories having to do with investments (gold's financial function) is sensitive to macroeconomic factors and swings from year to year. In 2018, despite pressures on prices against a backdrop of a trade war between Peking and Washington, attention has been centered around the question of transparency in the listing and transactions of gold on the principal marketplaces worldwide. This question has oriented the markets...

Using gold nanoparticles in catalysis

Delphine Schaming, associate professor, Laboratoire ITODYS, Paris Diderot University

Several studies are being made of catalysis, an important field in chemistry, since 90% of chemical processes in industry involve catalysis in at least one of their stages. In research laboratories, new materials are being developed with multiple properties. The recent interest in nanoparticles, in particular of gold, opens new prospects for catalysis. Given their very small size, nanoparticles are highly reactive, unlike gold, which is known for its chemical inertia at the macroscopic scale. Furthermore, they are at the origin of a physical phenomenon, plasmon resonance, which endows them with photocatalytic properties.

Gold in history and civilization, history and the arts

Myriame Morel-Deledalle and Jean-Roch Bouiller, curators of the exhibition on gold at the Museum of European and Mediterranean Civilizations (MUCEM, Marseille)

Questions can always be asked about the grounds for a convergence between archeology and contemporary art. The exhibition on gold organized in 2018 at MUCEM in Marseille addresses these questions. It distinguishes this precious metal's monetary value from its properties, both plastic and symbolic. As we see from its history, gold has

had an important function in nearly all societies, during all periods and in all latitudes. In this sense, it is a matter of civilization that, in addition, has links to several current social questions. Gold has also been a material worked by artists and craftworkers; and interest is, once again, being shown in their creations. Most contemporary artists propose a political or poetic approach to gold – some are critical of its monetary value (as a means of alienation), while others play on this value or propose approaching gold as a material but for the purpose of revealing its metaphysics.

Measuring gold and making it traceable from its origins: The metrology of powders and molten gold

Laurent Bailly, Anne-Marie Desauty, Philippe Lach, Wolfram Kloppmann and Isabelle Duhamel-Achin, Bureau de Recherches Géologiques et Minières (BRGM)

Since Ancient Times, people have sought for new methods to determine how pure gold is. Nowadays, the challenge to science is to precisely assay the impurities in gold. Several techniques analyze the chemical signatures of these impurities. Whether destructive or not, whether global or *in situ*, these signatures characterize a sample's heterogeneity. The science of archeology uses the signature of impurities to trace the circulation of ancient objects. When prospecting, this signature is used to locate primary deposits. In the fight against the illegal mining of gold and trade in it, establishing a tracking system on supply chains has become an obligation for importing firms. The chemical signature of the impurities contained in gold, along with the isotopic and mineralogical signatures, holds promise for tracking gold.

Michèle Rousseau (BRGM) has written a foreword for this article.

3 - Gold for money and banks

The gold market and central bank reserves

Nathalie Aufauvre, Bank of France

Central banks are historically the witnesses to, and key players in, gold as an asset (monetary and then financial). Till the end of the 20th century, the management of gold reserves in central banks, mostly in developed countries, very much depended on gold's place as a monetary asset. This aspect gradually yielded to a more financial conception owing to successive financial crises since 2008. In this context, the central banks of emerging countries are playing a larger role as these countries have become net buyers of gold.

The place of gold in French savings and the means for mobilizing it

François de Lassus, CPoR Devises, Tessi Group

Till the end of the 1960s, France was a worldwide reference for investments in the physical gold market, given the sizeable volume of transactions there. This thriving market co-existed with a “nest egg” of at least 3000 tonnes. Although this precious metal's market price inevitably dropped during the 1970s, this golden egg's size

remained stable, whereas it should have diminished in due proportion. In fact, 80% of people with savings in France have gold that was acquired during the period of prosperity following WW II or has been passed on as an inheritance. They do not want to sell since this asset is taxed, when resold, at a rate they deem excessive. If the law were modified in a less confiscatory sense, 8% of persons who own gold would be ready to sell it. “Liberating” as little as 5% of this nest egg would supply the economy with the equivalent of €4.5 billion.

The exoticism of gold coins and the governance of monetary systems

Vincent Bignon, Bank of France

Gold was used as money on nearly all continents, except Asia where silver was traditionally current. What stands out when examining metal-based monetary systems is the similarity to the problems with which systems using fiat money have to cope. Time does not simply march forward during the history of money. The French and German economies experienced hyperinflation during the Middle Ages or Renaissance; and kings waged monetary warfare with each other. Governance is just as crucial in metal-based as in fiat monetary systems. The origins of the mintage of gold are described; and the reasons legitimating this choice, reviewed. Governance is of crucial importance in gold-based monetary systems.

From monetary to financial gold

Tanguy Aubert and Christian Pfister, department of statistics, Bank of France

The function of gold as a monetary asset has gradually waned, at first in transactions and then in the international monetary system (whence it was eliminated in 1973). For the public, gold can serve as a financial asset by protecting against inflation in the very long term and by serving as a safe investment during crises of a global (but not necessarily regional) scale.

Miscellany

Two articles in a followup to the August 2018 issue, “Ten years ago, the meltdown: Regulating finance and new issues”.

The Retreat from Systemic Risk Regulation: What Explains It? (and Why It Was Predictable)

John C. Coffee, Jr., Adolf A. Berle Professor of Law at Columbia University Law School and Director of its Center on Corporate Governance

Financial crises usually trigger a predictable cycle: first, a populist outburst that produces dramatic legislative and regulatory changes and, then, a slower counter-reaction as the financial industry gradually subjects the new reforms to a death by a thousand cuts, often with the result that little remains. This cycle – here called the “Regulatory Sine Curve” – can be traced back to the South Sea Bubble in 1720. In the aftermath of 2008, this cycle seems to be again in progress in the United States, as many of the Dodd-Frank Act’s reforms have either gone unimplemented or have been partially repealed. But the same cycle does not appear to be occurring in Europe. This brief essay analyzes these differing responses and seeks to explain why Europe seems better insulated against counter-reaction.

Delegating Regulation: European Union and Financial Markets

Sharyn O’Halloran, Columbia University, Karen Chen, Rudra M Guha Biswas, Hoon Kim, Pu Liu, YouFei Zhang and YunPeng Zhou

This paper analyzes the design of financial regulatory structure in the European Union. We develop a two-pronged approach to track changes in decision-making authority in EU financial market regulations and directives enacted from 1964 to the present. Traditional observational data collection methods manually code laws to identify the amount of discretionary authority delegated to regulatory bodies that oversee segments of financial markets. The lack of robustness and scalability of this approach, however, may limit the generalizability of observational studies. To remedy these potential shortcomings, we match observational methods with data science techniques, in particular natural language processing, to visualize complex patterns in the text of laws and temporal movements. The combination of both observational and computational approaches provides more detailed insights of the various elements of financial regulatory structure and the temporal allocation of decision-making authority among the European Commission, regulatory agencies and the Members States. Our analysis indicates that both the scope and location of decision-making authority shifted over time, moving from Member States to EU regulatory agencies. The amount of discretionary authority delegated to EU agencies to implement regulations, on the other hand, has remained largely unchanged.

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