REPORT R118/2016

ECONOMIC POTENTIAL AND STRATEGIC RELEVANCE OF FLUORSPAR

DIRECTORATE: MINERAL ECONOMICS

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ABSTRACT

Fluorspar, also called fluorite (CaF_2) was identified by the British Geological Survey (BGS) as a strategic mineral in 2012, because it is vital for the production of a wide range of chemicals, including refrigerants, polymers, lubricants and pharmaceuticals. Two fluorspar grades are important in terms of traded volumes, which are acid grade fluorspar (acidspar) and metallurgical grade fluorspar (metspar). Acidspar which has a minimum of 97 percent CaF_2 is fundamental for production of hydrogen fluoride (HF) and represents 49 percent of annual global consumption of fluorspar. Metspar with a content of 70 – 80 percent CaF_2, is used as a flux in steel making, which represents 47 percent of global fluorspar consumption. Furthermore, metspar is used in the glass and cement industries where approximately 4 percent is consumed.

South Africa has a convenient access to natural resources and accounts for the largest proportion of global reserves at 17 percent (41 Mt) but, it is ranked world's fourth producer at 3 percent (200 kt). The major producers are China at 61 percent (3800 kt), followed by Mexico at 18 percent (1100 kt) and Mongolia at 6 percent (375 kt). Fluorspar demand has been sluggish as a result of world oversupply and low prices. The major global fluorochemical producers were negatively affected by the depressed market, particularly in the refrigerant sector. South Africa's fluorspar industry continues to struggle as a result of difficult market conditions, operational limitations and penetration of the domestic market by other countries.

The fluorochemical market is likely to play a pivotal role in global industrial rebound despite the global economic slump due to a boost from infrastructure development in emerging economies generating demand for refrigerants, solvents and fluoropolymers. The speculation over cancellation of China's export tax on HF is likely to trigger demand for acidspar, as increased consumption rates will drive demand up in the country. This will also provide relief to existing stockpiles in the market and driving acidspar prices downwards, as some producers were selling stockpiles at prices below current levels preventing any recovery in the prices.

The aim of this report is to review the economic potential and strategic relevance of fluorspar. The report also covers related economic information regarding the beneficiation of fluorspar in the economy by looking at the upstream and downstream potential, as well as its contribution to the industrialization, inclusive growth and poverty alleviation as anticipated by key policy plans like the National Development Plan, the Minerals Beneficiation Strategy, National Industrial Policy Framework (NIPF), Industrial Policy Action Plan (IPAP), as well as the New Growth Path (NGP). It will attempt to identify opportunities that may exist for the South African fluorspar sector in downstream activities that have potential to grow the economy and possibly creating employment opportunities.

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1. INTRODUCTION

Fluorspar plays an integral part in South Africa's economy, used in countless industrial processes. Its primary use is in the production of HF with the largest use of the latter being the manufacture of refrigerant gases, aluminum fluoride which is used as a flux in the aluminum manufacturing process, fluorochemicals and in uranium enrichment to produce energy. South Africa is the fourth largest producer of fluorspar at 0.2 Mt and has the largest reserves at 41 Mt in the world. A larger proportion of fluorochemicals are derived from the mineral, fluorspar.

Fluorochemicals are chemical compounds that have a fluorine atom in their structure; they range from the simple fluorine gas (F_2) and HF to the more complex fluorinated organic compounds such as perfluorodecalin ($C_{10}F_{18}$). Fluorochemicals are largely used for consumer and industrial consumption. Although relatively inexpensive, fluorochemicals have a huge potential to contribute greatly to the economic development of South Africa. Although the fluorochemicals industry has contributed immensely to the growth of the chemical sector, their harmful environmental effects have resulted in the phasing out of fluorinated compounds, due to the high global warming potential. Environmental regulation is one of the most important influences in the global fluorochemical industry, especially in the area of fluorocarbons.

The concept of a green economy has gained currency to a large extent as it provides a response to the multiple crises that the world has been facing in recent years, the climate, food and economic crisis. It is an alternative paradigm that offers the promise of growth while protecting the earth's ecosystems while in turn, contributing to poverty alleviation. Greening the economy can generate consistent and positive outcomes for increased wealth, growth in economic output, decent employment, and reduced poverty. The green economy furthermore, provides an opportunity for the introduction of advanced technologies that will reduce the impact of fossil fuels in the atmosphere.

South Africa's intervention policies such as the New Growth Path (NGP) and National Development Plan (NDP) are developed with an aim of addressing the structural imbalances that have led to high levels of unemployment, poverty and inequality. These policies set a goal of five million new jobs by 2020 and eleven million jobs by 2030 respectively, building on the New Growth Path (NGP) approach. The country projects that, with the right policies and cooperation, large numbers of green jobs can be created. Driving the defining trends of the transition to a green economy includes increasing human well-being, social equity, as well as reducing environmental risks and ecological scarcities.

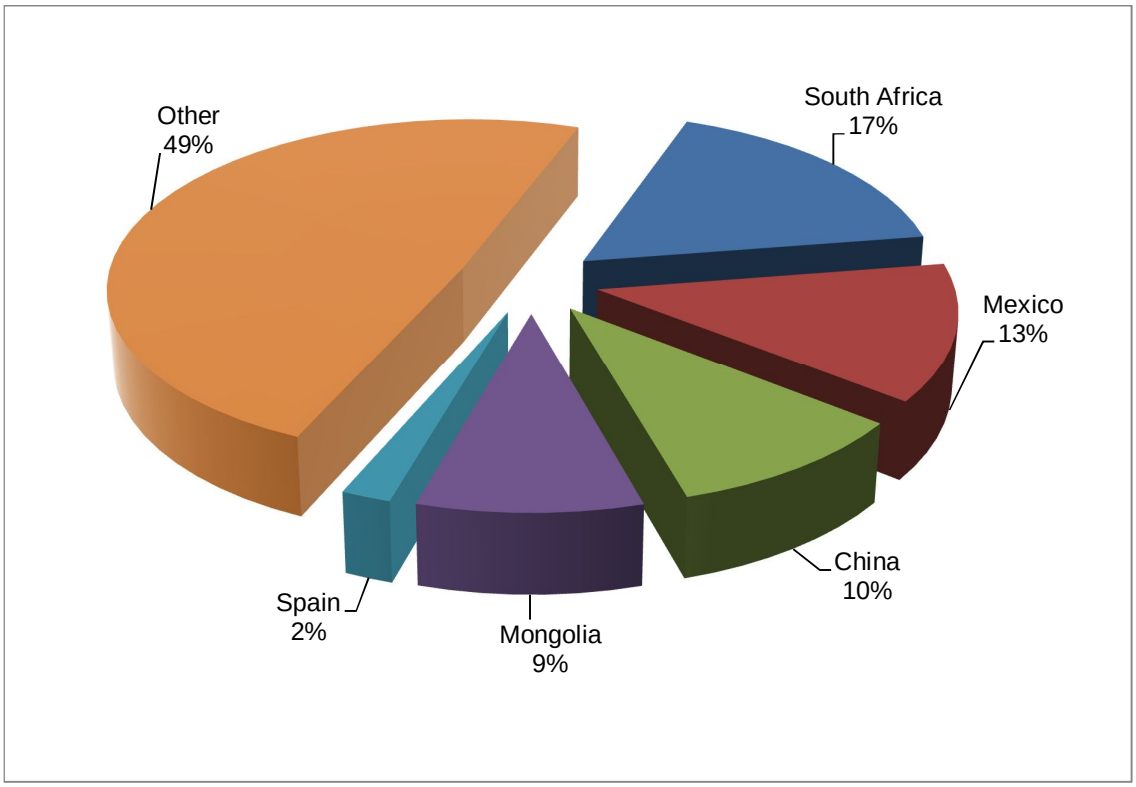
2. OCCURRENCES AND RESERVES

Fluorspar is found in a variety of geological environments on every continent veins and as deposits from hot gasses, and it is mined either as a main commodity or as a co-product of metal mining. It contains 51.1 percent calcium and 48.9 percent fluorine. Studies have shown that fluorspar is very easy to identify through its cleavage, hardness and specific gravity. It has a specific gravity of 3.2 which is detectably higher than most other minerals. Most fluorite occurs as vein contents in rocks that have been subjected to hydrothermal activity. These vein deposits often occur as the main mineral or with metallic ores which can comprise sulfides of tin, silver, lead, zinc, copper and other metals.

Vein deposits are found around the world and include the El Hemman deposit in Morocco, the Rosiclane deposit in United States of America (USA), Osor deposit in Spain and recently exploited deposits in China. Replacement deposits are associated with intrusive igneous rocks, such as the Rio Verde deposit, San Luis districts deposit in Mexico and Vergenoeg deposit in South Africa. Stratiform deposits are typified by cave; such as Illinois deposit in the USA.

The world reserves of fluorspar are estimated at 248 Mt. South Africa holds the largest fluorspar reserves globally accounting for 17 percent (41 Mt), followed by Mexico at 13 percent (32 Mt), China's 10 percent (24 Mt), Mongolia's 9 percent (22 Mt), while Spain accounted for 2 percent (6 Mt) (Fig. 1)

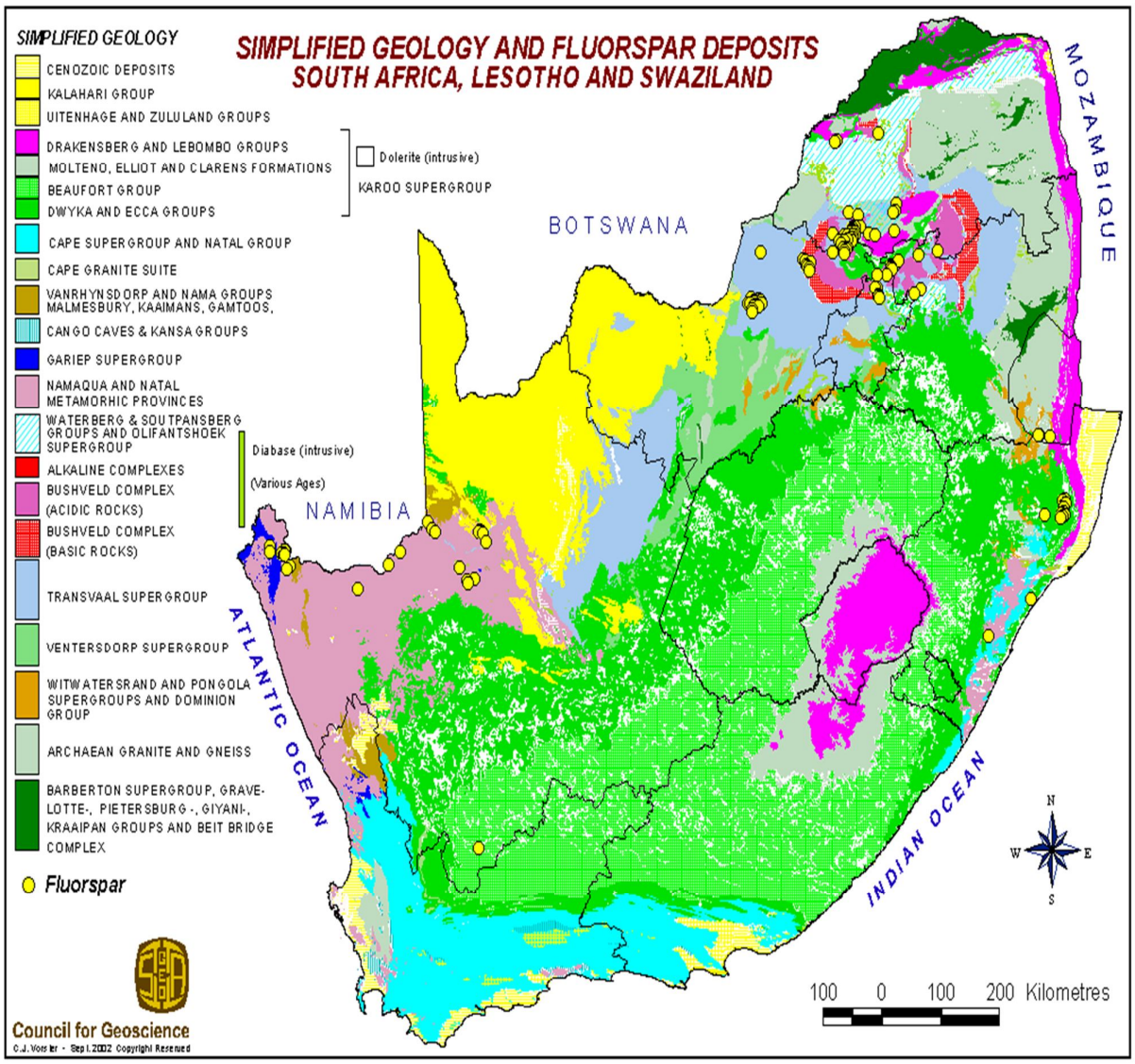
FIGURE 1: WORLD FLUORSPAR RESERVES BY COUNTRY, 2015



Source: USGS, 2016

South Africa is the single largest host of fluorspar reserves in the world with most of these resources found in the Bushveld Complex (Fig. 2) – currently mined by Vergenoeg, jointly owned by Spanish company called Minerales y Productos Derivados SA (Minersa) with 85 percent share and MEDU Capital, 15 percent. Fluorspar deposits are also found in the Malmani subgroup of the Transvaal Supergroup (Fig. 2), in the south western part of Marico District, south of Zeerust, which was mined by Witkop and owned by Fluormin 63 percent and Sallies 37 percent (Fig. 2).

FIGURE 2: FLUORSPAR DEPOSITS IN SOUTH AFRICA



Source: Council for Geoscience

3. STRUCTURE OF THE FLUORSPAR INDUSTRY

Vergenoeg is the only operating fluorspar mines in South Africa. Witkop mines ceased operation when the market started to stumble in 2012. Vergenoeg is one of the largest in the world with a growing production capacity (240000t/pa) of acid-grade fluorspar and metallurgical grades in various formats.

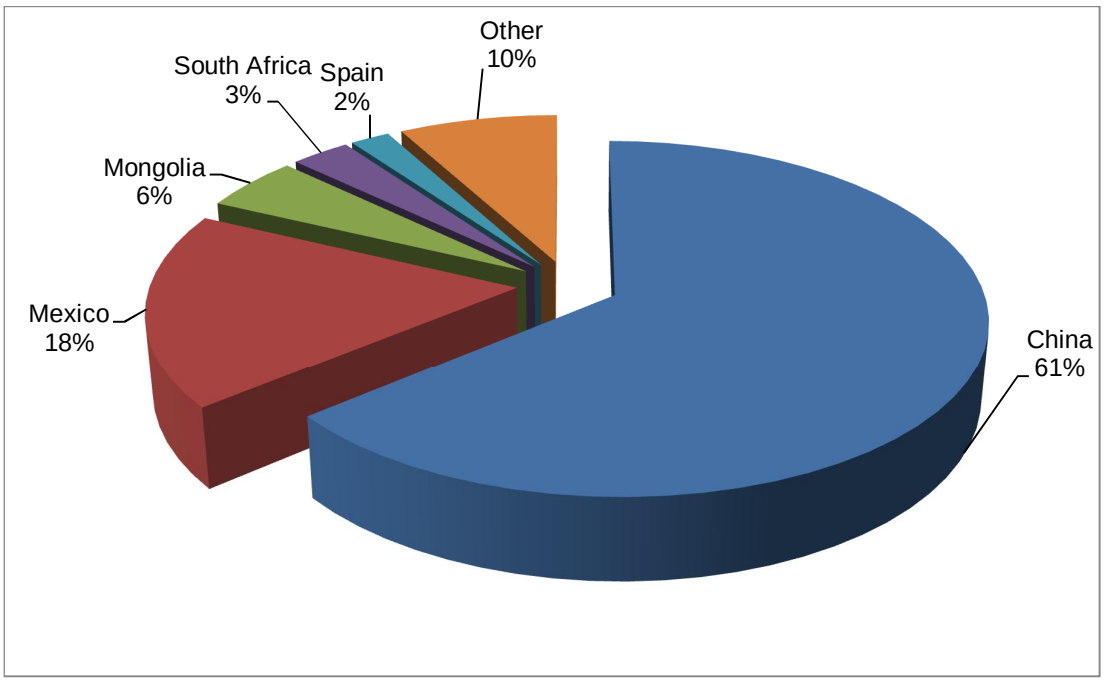
The main consumer of fluorspar in South Africa is Sephaku Fluoride Limited (Sepfluor). It is the South African manufacturer of fluorochemicals. Necsa is the producer of hydrogen fluoride (HF) and other fluorochemicals. Hydrogen fluoride and other fluorochemicals have played a vital role in the development of nearly all industries including the nuclear fuel programs, the development of commercial refrigerants, metal processing industries, petroleum industry and the development of high performance thermoplastics.

South Africa exports its fluorspar in Europe for the hydrogen fluoride beneficiation and the production of aluminum fluoride. The country imports facilities for downstream products from overseas at a higher cost. The fluorspar market has been experiencing sinking price trends since 2014. Currently, prices of commodities are low, and some were affected by the decline in fluorochemicals demand among other factors. This effect poses a negative impact on the suppliers of fluorspar as hydrofluoric acid and aluminum fluoride prices are also under pressure in discounted markets. This weaker demand affects earnings negatively.

4. SUPPLY AND DEMAND

Total world production of fluorspar decreased by 144 Kt to 6.25 Mt in 2015 compared to 6.39 Mt in 2014, due to the decrease in fluorochemical demand. China and Mexico are the leading global producers at about 70 percent of total production output, with China accounting for 61 percent and Mexico for 18 percent, followed by Mongolia at 6 percent, South Africa as the world's fourth producer at 3 percent and the rest accounting for 10 percent (Fig. 3).

FIGURE 3: WORLD FLUORSPAR PRODUCTION, 2015



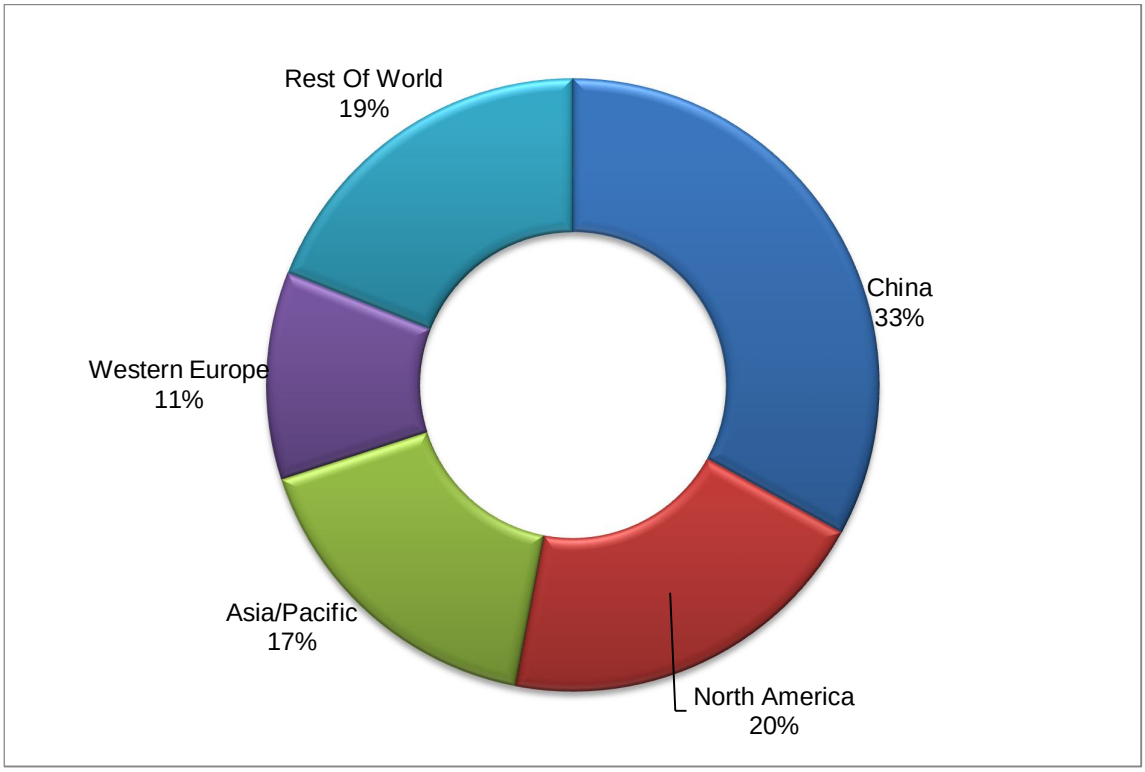
Source: USGS, 2016

Fluorochemicals industry has a potential to play a key role in the development of the South African manufacturing sector (through the chemical industry), thus contributing greatly towards the creation of much needed employment in the country. The mining industry contributes about 18 percent indirectly to the country's GDP, indicating that by tapping into its fluorochemicals industry the country has the potential to achieve its economic growth targets of 5.4 percent GDP growth and 6 percent employment by 2030 as envisaged by the NDP.

China remains the major producer of fluorspar which accounted for 61 percent in 2015. Generally, the majority of China's fluorspar production is exported, but the country spent the last decade building and growing its fluorine based chemical industry. China adds value to its domestic acid-spar supply through the production of downstream products such as hydrofluoric acid, fluorocarbons, and fluoropolymers rather than exporting the mineral.

Fluorspar demand is driven by uses in fluorocarbon applications, which include consumer goods such as fridges, freezers and air conditioners as well as steel and aluminium fluoride production. Chinese fluorspar demand was 33 percent, followed by North America at 20 percent, Asia/Pacific at 17 percent and Europe at 11 percent in 2016 (Fig. 4). South Africa's local industries demand is minimal, however, the country is anticipating growing and supporting the downstream activities through its vigorous drive to industrialise the economy.

FIGURE 4: WORLD FLUORSPAR DEMAND BY COUNTRY, 2015

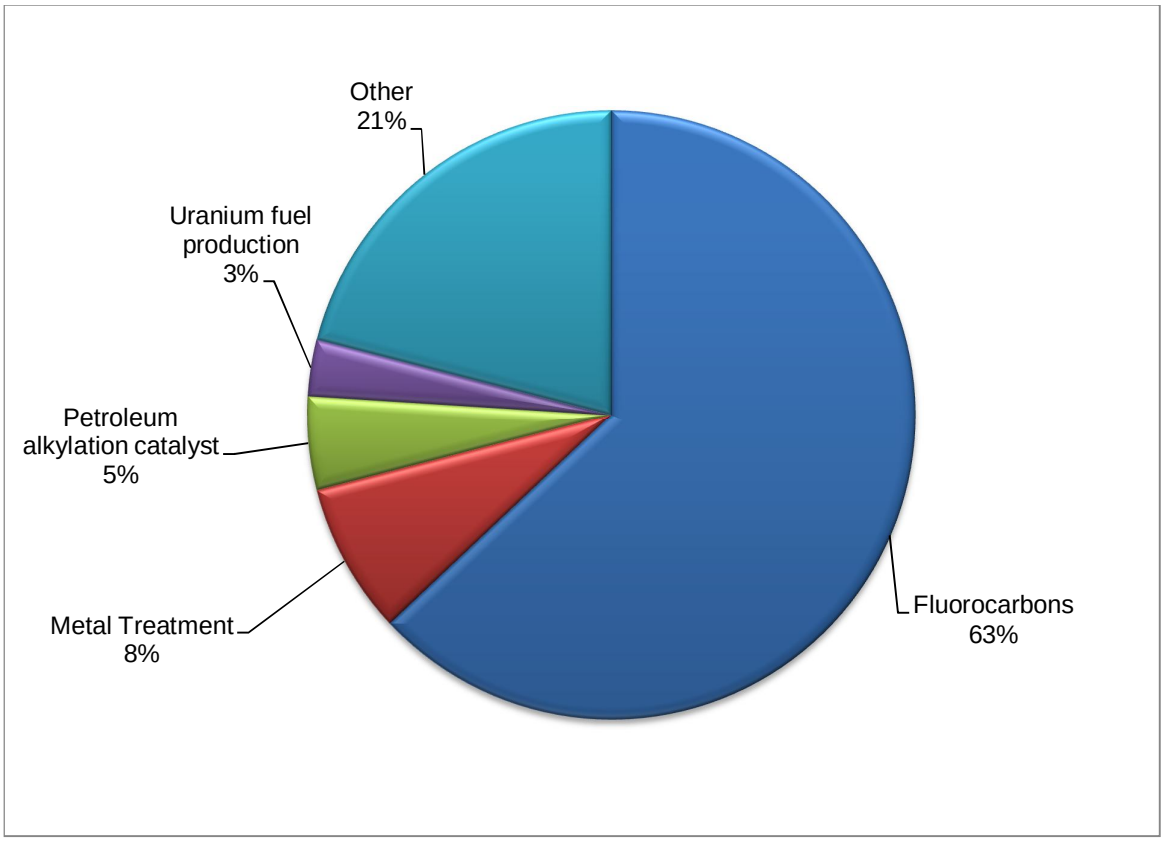


Source: Freedonia, 2016 Report

The global fluorochemicals demand estimated at $20 billion, has been growing steadily over the last three years on account of increasing application scope, technological innovation, and growing demand in Asia-Pacific. Fluorochemicals include fluorocarbons, inorganics and specialty fluorochemicals as well as fluoropolymers. Inorganics generally include fluorochemicals such as aluminium fluoride, fluorosilicate, silicofluoride and cryolite. Fluoropolymers are the most promising product segment in the global fluorochemical market.

Fluorocarbons accounted for 63 percent of HF global consumption in 2014, followed by metal treatment at 8 percent, petroleum and alkylation catalyst at 5 percent and uranium fuel production at 3 percent (Fig. 5). The refrigerant and air conditioning gases markets account for almost half of the total fluorocarbon consumption globally. Moderate growth of about 2 percent is expected over the next few years. Many changes are looming in the global fluorspar industry over the next 15 years, as hydrochlorofluorocarbons (HCFCs) are being restricted and gradually substituted by gases with a lower global warming potential.

FIGURE 5: WORLD CONSUMPTION OF HYDROFLUORIC ACID, 2014



Source: IHS Inc. 2015 (formerly known as SRI Consulting)

The United States and Western Europe demand of acidspar outside China which is mainly used in the production of HF. In China, cement and glass industries generate the largest demand for fluorite and the fluorite demand from the fluorine chemical industry is increasing. However, fluorspar exports from China have come under restrictions, and obtaining access to these raw materials becoming a challenge to fluorochemical suppliers. The suppliers of fluorochemicals are also faced with the increasing competition from alternative products, particularly in the blowing agents and commercial refrigeration industries, as well the ever-shifting regulatory environment for fluorocarbons.

Environmental regulations are the strongest force acting on the industry, which are helping to shape demand in both positive and negative way. While consumer concerns reduced demand for some fluorine-based products, they have also opened up opportunities for products such as newer fluorocarbons with low global warming potential (GWP).

5. USES

The primary uses of fluorspar are in the metallurgical, ceramics and chemical industries; however, optical, lapidary and other uses are also key. Fluorspar is mainly sold in three different grades; acid, ceramic and metallurgical.

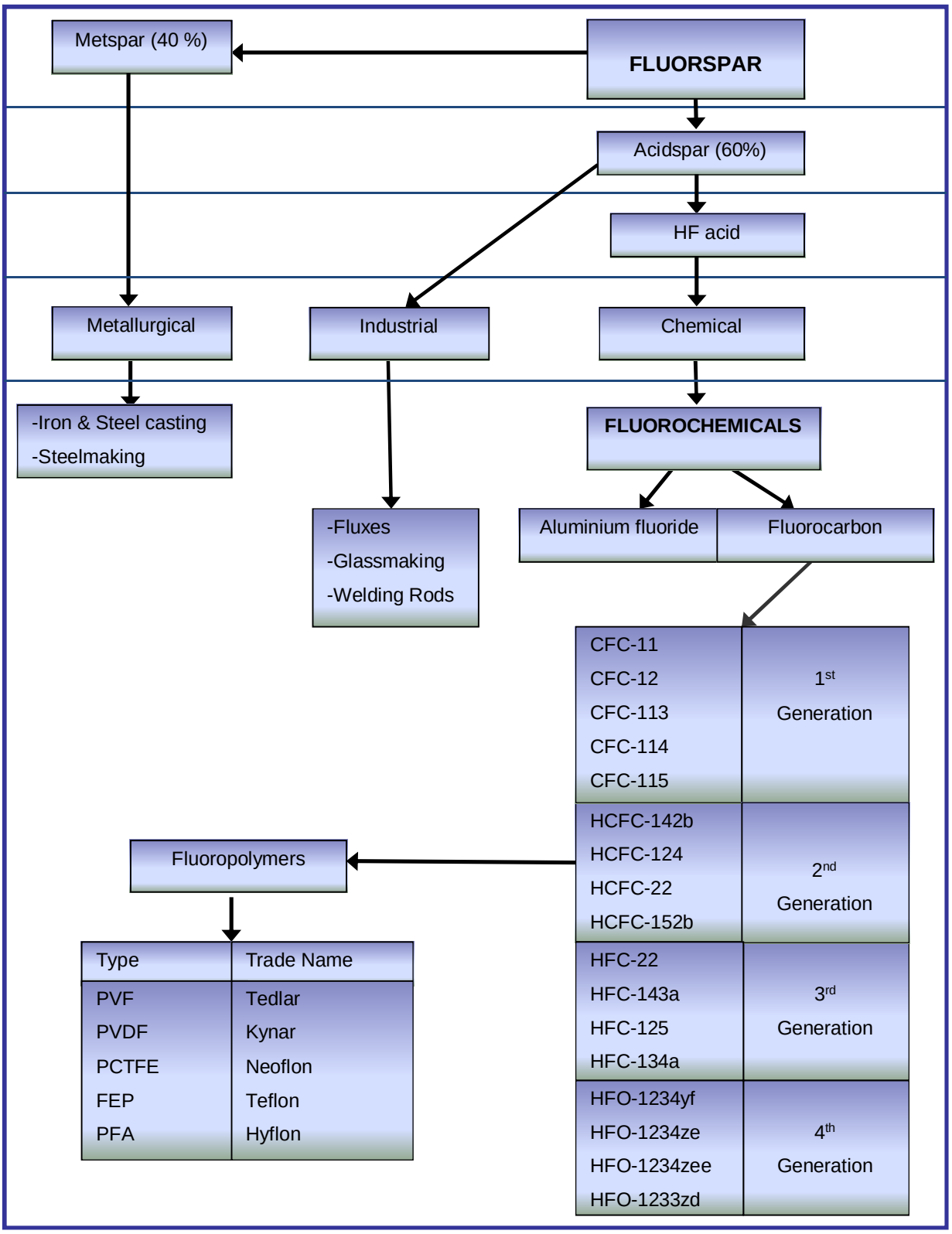
Acid-grade fluorspar is used in the manufacture of hydrogen fluoride, which in addition is required for the production of a range of fluorochemicals. Demand for fluorspar is dependent on the hydrogen fluoride demand and an associated fluorocarbon production. There are other multiple uses also, in the fiberglass, welding rod, and glass industry. It is also used in blending with burned lime & dolomite for the steel industry. Calcium fluoride is used as component of electrolyte, fluxing agent for aluminum metallurgy.

Fluorite can be drilled into jewellery; however it is not used as a semiprecious stone due to its relative softness. The pure form of fluorite is used for manufacturing of hydrofluoric acid, which acts as an intermediate source for most of the fine chemicals containing fluorine. The chemical industry and glass industry accounts for the major share of the fluorine demand globally. The key segments for fluorite market include North America, Asia Pacific, Europe and Rest of the World (ROW). Western Europe, China and the U.S. are said to be the major consumers of fluorite worldwide. Western Europe and the U.S account for major demand for acid fluorite. The cement and glass industry in China generate the largest demand for fluorite and are expected to drive the market globally.

Multiple fluorite enterprises are focusing on strengthening the integration of downstream and upstream industry chain of fluorite reserves for avoiding price volatility and to achieve higher value for its products. Mexichem enterprise has large reserves of fluorite that produces fluoroelastomers and fluoropolymers for benefits.

The development of fluorspar from extraction to buyers goes through mining, processing, intermediary products, market sectors (i.e. metallurgical, industrial and chemical market sectors) and the target market (Fig. 6). After fluorspar is mined, it is separated and 40 percent is recovered as metspar and 60 percent is processed into acidspar. 20 percent from the 60 percent of acidspar is used further in the industrial sector for fluxes, the fabrication of specialty glass and welding rods manufacture. And the remaining 40 percent of the acidspar is beneficiated into intermediary product producing HF.

FIGURE 6: FLUORSPAR FROM MINE TO MARKET



Source: Industrial Minerals IM Data, 2014

Fluorine has a wide range of pharmaceutical and medical application. The combinations of fluoride are applied in antibiotics and anesthetics as well as in arthritis treatment. Most toothpaste also comprise of fluoride to strengthen tooth enamel, thus preventing tooth decay. Some of the diverse uses of fluorspar are summarized in Figure 7 below.

FIGURE 7: FLUOROCHEMICAL USES

Source: Freedonia Group, 2009 Report

6. ECONOMIC BENEFITS OF FLUORSPAR

South Africa has been a resource economy in excess of a century. An independent evaluation of South Africa's non-energy institute mineral wealth is estimated at US$2.5 trillion (Citibank report, May 2010), making the country the wealthiest mining jurisdiction. However, a considerable amount of South Africa's mineral resources are exported as raw ores or only partially processed.

The Government's industrialization policy calls for a paradigm shift in mineral development, strategic investment in assets to maximize long term growth beneficiation projects, enhance value of exports, increase sources for consumption of local content, and create opportunities for sustainable jobs. Minerals are a vital input to an industrialization programme, which is intended to accelerate manufacturing in South Africa (for local consumption and export). Competitive access to minerals for local beneficiation is one of the key success factors for the country's industrialization initiative.

South Africa intends to reduce the negative balance of payments in the chemical industry by supporting focused research and development (R&D), aimed at new process, and product development, some of which may help to create new industries. The country currently supplies around 10% of the global fluorochemical industry's fluoride requirements worth about US$16 billion a year but captures less than 0.5 percent of this revenue owing to the low level of local beneficiation. South Africa hosts the world's largest reserves of fluorspar, estimated at about 41 million tons and niche expertise in the processing of fluorine and hydrofluoric acid at the Nuclear Corporation of South Africa (Necsa) and at Pelchem SOC Ltd, which can be used into a competitive advantage gearing towards the fourth industrial revolution.

The Fluorochemicals Expansion Initiative (FEI) aims to increase the capacity base and depth of fluorochemical technology through focused R&D projects which could result in a pipeline of novel and viable commercial opportunities. The Department of Science and Technology (DST) funds technology and innovation development programmes to advance strategic medium and long-term sustainable economic growth towards addressing the triple challenge of poverty, unemployment and inequity in South Africa. Equal investment by its partners is essential in this instance, as this would strengthen the department's efforts substantially. Advances have been made in commercialization of some chemicals and processes in support of downstream value addition of fluorspar in South Africa and opening potential for new markets.

Pelchem Company currently supplies 25 advanced products to 27 countries on six continents. This opens great opportunities to expand the product portfolio and capabilities in partnership with government, research institutes and the industry. These include products used in lithium ion batteries, active pharmaceutical ingredients, advanced materials and specialty solvents and electronic gasses, among others.

The fluorspar industry extends beyond the direct wealth and employment generated by customers purchasing fluorspar. Some benefits to the economy are also achieved through the interaction between

fluorspar and other industries. The industry requires inputs such as a variety of consumer goods and services including fuel, transport, machinery and consultancy services, to function. Securing these inputs will ensure that the country generates economic activity and employment.

Fluorochemical production is a major application of fluorspar. Rising demand for fluorochemicals from various end-use industries is projected to drive demand for fluorspar. Fluorocarbons are primarily used as refrigerants in household air-conditioning, industrial refrigeration equipment, and as blowing agents. The expected global economic recovery and subsequent rise in the production of automobile, mobile phones, pharmaceuticals, steel and aluminum manufacturing, will help spur demand for fluorochemicals in the not so distant future. Refrigeration is an important end-use market for fluorochemicals. With pressure mounting to phase out ozone-depleting refrigerants, a rapid transition to eco-friendly refrigerant alternatives is underway, and demand for HFC blends and hydrofluoroolefins (HFOs) is expected to gain momentum in the near future.

China ranks as both the production hub and as the leading consumer of fluorspar worldwide. Fluorspar production in other parts of the world declined sharply over the years due to decreased consumption of fluorspar among fluorochemical manufacturers based in developed economies and also due to tough competition from low-cost Chinese producers. Despite the fact that China dominates global fluorspar production, the country houses only 10 percent of global fluorspar reserves. With China fast running out of fluorite reserves, there is a growing focus on exploration and mining of fluorspar in countries with huge known reserves such as Mongolia, South Africa and Mexico.

7. UPSTREAM

South Africa has a well-established and concentrated upstream chemical manufacturing sector. It is mostly technology intensive in the production of basic chemicals as raw materials or feedstock. The capital-intensive operations tend to be automated to ensure that products meet the required quality and specification consistency. However, the upstream chemical sector is not well designed to accommodate greater quantity of employment or the development of Small Micro Enterprises (SMEs).

There was sluggish production of fluorochemicals throughout 2015 due to the decline in demand for fluorspar. Acidspar prices have also dropped and it is not likely to experience growth before the second half of 2016. The decline in acidspar prices was due to the overcapacity in Chinese fluorochemicals sector which influenced fabricators to deluge export markets with excess production.

The Fluorochemical Expansion Initiative (FEI) is in line with the larger national programmes such as National Industrial Policy Framework (NIPF), the Advanced Manufacturing Technology strategy and beneficiation strategy for SA minerals in developing the fluorochemicals industry through improved local beneficiation of the country’s fluorspar reserves.

8. DOWNSTREAM

Deteriorating prices and weak downstream demand for fluorochemicals are threatening to limit new entrants into the fluorspar mining industry but, new low cost suppliers from Vietnam are beating the market odds, notwithstanding the detriment of existing producers in South Africa, Namibia and Russia. The difficult market conditions led to closure of some of the fluorspar mines including the Witkop and Buffalo mine in South Africa and Okurusu in Namibia. In the fluorochemicals market, fluorspar industry players are eager to see how new regulations and environmental laws designed to limit global warming emissions are going to impact their businesses and fluorspar consumption rates.

Pharmaceuticals also represent an opportunity for fluorspar. About 25 percent of all marketed drugs contain fluorine, but this accounts for merely a fraction of fluorspar demand in terms of volume. Existing and new producers alike, are actively engaging in R&D into growing existing applications of fluorspar as well as identifying new uses – a trend common to both acidspar and metspar, as the industry looks to innovate its way out of the current market trough.

The downstream chemical sector is diverse, but underdeveloped. This sector is responsible for turning the raw materials into intermediate or final products. The operations of this sector are normally labour intensive and entails formulation production processes, in which the incubator programme of government can have a positive impact in creating vibrant Small Micro Enterprises (SMEs). Consequently, the sector is celebrating being able to maintain levels of employment over two decades.

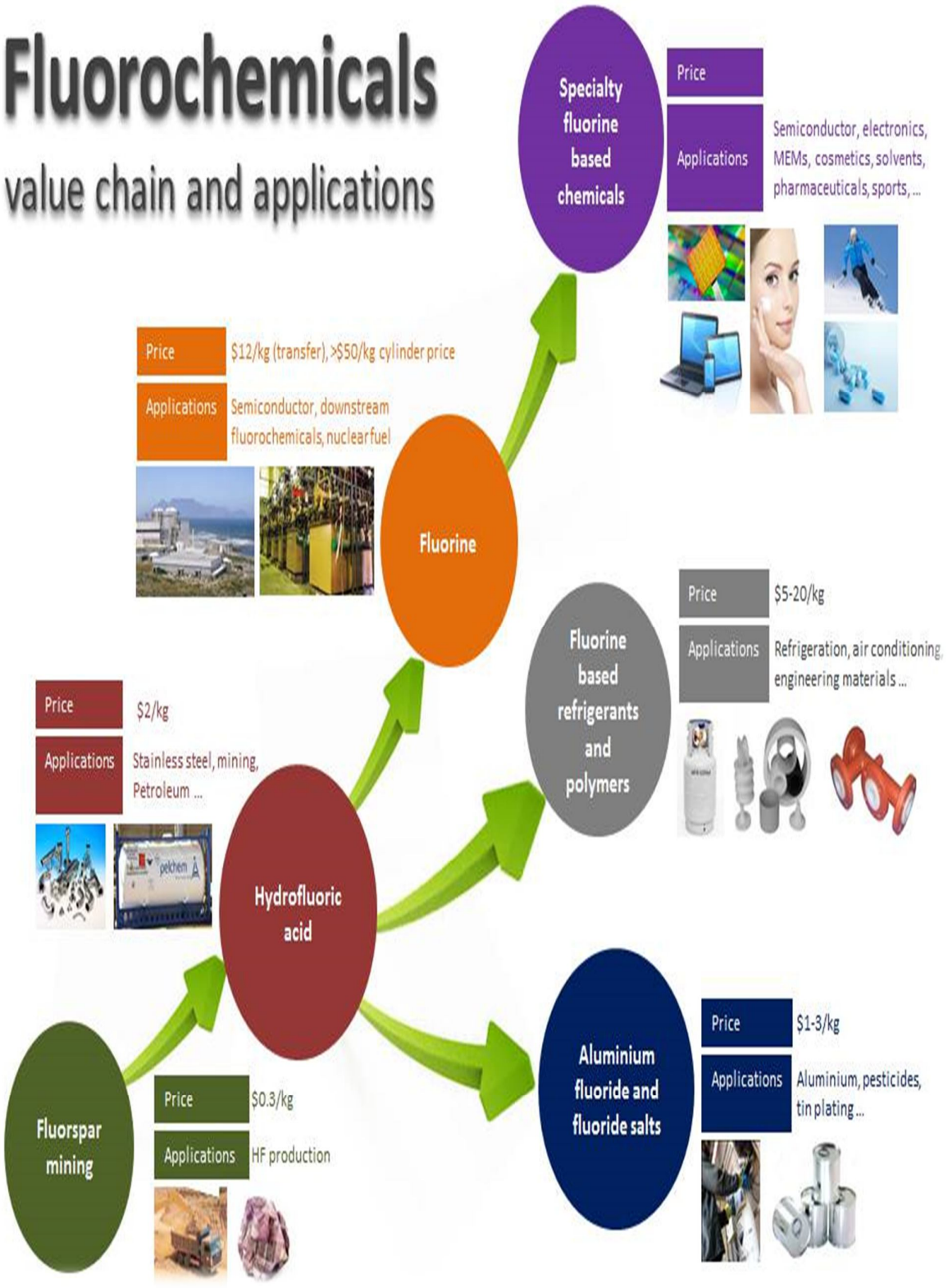
Other applications for more downstream are: motor vehicles, pharmaceuticals, construction materials, plastics, fluorochemicals, health care equipment, electronic and electrical equipment. Growth in demand for fluorspar consumption has been associated with increased production of fluorochemicals that contributes massively to a green economy (Table 1).

TABLE 1: DOWNSTREAM CONTRIBUTION OF FLUORSPAR: GREEN TECHNOLOGY

Sector	**Contribution to green technology**
Solar panel manufacturing	• Nitrogen trifluoride (NF_3) and Fluorine (F_2) are used for manufacture of thin film solar panels. • Fluoropolymer coating (are blends of high performance resins and fluoropolymer lubricants)
Biodiesel	• Fluoropolymers are used as sealing materials
Renewables	• Neodymium magnets (NdFeB) are used in super magnets for wind turbine generators
Electric vehicles	• $LiPF_6$ batteries for energy storage for electric vehicles • Neodymium magnets are used in electric vehicle motors
New low global warming potential refrigerant	• New hydrofluoroolefins such as CF_3-CF=CH_2 are being promoted as the next big refrigerant in the automotive sectors whilst various fluorocarbon and hydrofluorocarbon blends will continue to dominate other refrigerant applications.
Insulation	• Fluorinated liquids to produce non-flammable insulating materials • Fluoropolymers used as insulation material in building construction as well as in automotive and aerospace industries.
Reducing toxic emissions	• Surface fluorination of plastic containers reduces the emissions of harmful solvents and hydrocarbon fuels such as xylene and petrol
Nuclear	• Hydrofluoric acid and fluorine gas plays an integral role in the nuclear fuel cycle and plays a critical part in localisation.
Food security	• The agricultural market provides outlets for fluorochemical-based herbicides, insecticides and fungicides. Fluorinated compounds such as sodium silicate fluoride (Na_2SiF_6) have been shown to be more potent than their non-fluorinated counterparts - this allows for lower amounts of chemicals used. Sulfuryl fluoride (SO_2F_2) is used in gas fumigants to reduce the incidence of rats, mice and other pests from invading food storage and transportation structures.

Note: The contributors to green technology have fluorine content

FIGURE 8: FLUORSPAR VALUE CHAIN



Source: Pelchem 2015

9. ENVIRONMENTAL ISSUES

A few studies have been carried out in which the fluoride exposures have been via the soil. The type of soil can greatly affect the uptake and potential toxicity of fluorides. Studies have shown that fluoride is an industrial pollutant (when mined) which affects both human health and the environment. Many people worldwide, who are working in the fluoride industry are at risk for catching health infections such as difficulty in breathing, eye irritation, nervous wreckage and other severe health infections as exposed by fluoride activities.

Fluoride air pollution further poses effects on plants such as timber varieties, in a sense that they get damaged, animals get sick from skeletal abnormalities owing to the extended drinking of contaminated water from which they eventually die. Aluminum smelters, brickworks, phosphorus plants, fertilizer and fiberglass plants have also been proven to be sources of fluoride that are correlated with damage to local plant communities. Plant communities near an aluminum smelter showed differences in community compositions, partly due to variations in fluoride tolerance.

South Africa extracts most of its raw material from the earth's surface, thereby ensuring that sustainable development exists and consumption is not exhausted completely in order for the future generation to benefit from it. As South Africa's chemical industry is relatively still in its early stages, regulation remains the largest threat in the fluorochemicals industry. Consequently, environmentally friendly alternatives are required. Greenhouse gases (GHG) impact negatively on the environment as a whole; causing radical climate change and depleting the fluorspar resources. Therefore, there is an on-going concern regarding fluorocarbons contributing to climate change.

Fluorochemicals have a high global warming potential and as a result this sector has been challenged by strict regulation and the phasing out of fluorinated compounds, especially certain fluorocarbons. The Montreal Protocol (to protect the ozone layer) affected the demand as it called for the phasing out of the use of a number of high fluorspar consuming chemicals; mainly the CFCs. CFCs are the original refrigerants and propellants. The combination with ozone damaging chlorine (Cl), which is administered by the Montreal Protocol and the Kyoto Protocol (on climate change) affects a number of other fluorochemicals as well, mainly those with high global warming potential. More recently, the 2009 United Nations Climate Change Conference (UNCCC), commonly known as the Copenhagen Summit, discussed a framework for climate change mitigation beyond 2012.

South Africa has also put in place progressive, innovative and proactive policies and plans to deal with the ever-changing climate. These policies are guided by the central principle of sustainable development, which is the foundation of Vision 2030 contained in the National Development Plan (NDP). The country has a National Strategy for Sustainable Development, a National Climate Change Response Policy, Green Economy Strategy, and an Integrated Resource Plan (IRP), and additionally an Industrial Policy and Action Plan that recognizes that, energy efficiency and less-carbon intensive production are central principles of a green economy. Furthermore, National Adaptation Strategy is underway to guide South Africa's efforts to plan for and adapt to the impacts of climate change.

10. GOVERNMENT'S INTERVENTION POLICIES TO GEAR THE FLUORSPAR INDUSTRY

There are key policies like the National Development Plan (NDP), New Growth Path (NGP), Beneficiation Strategy, Carbon Tax and an Integrated Resource Plan (IRP) policy that are likely to benefit fluorspar into fluorochemicals thus adding more value to abundant local resources in order to grow the economy and develop the industry. With the National Development Plan, the local government would have increased exports on areas that are of comparative advantage-such as the fluorspar industry as most of it is exported at an unbeneficiated manner by 2030 and where the country has endowments such as mining, construction, agriculture, agro-processing, mid-skill manufacturing, higher education, and tourism and business services.

South African government has selected the manufacturing sector for support, as it has acknowledged its important role in achieving economic growth in the country. The department of Trade and Industry (the dti) as the curator of manufacturing for industrial development is targeting the chemical sector to make industrial capacity thus creating opportunities for industrialization. The dti also offers inspiring incentives to private industrialists who wish to start fresh fluorochemical projects that are sure to develop the chemical industrial structure. Those include 12i tax incentive and critical infrastructure program providing financial assistance to qualifying companies and assets. The 12i tax incentive offers support for both capital investment and training in new industrial projects or upgrades on existing ones. Through the Operation Phakisa, the ocean economy will be unlocked with the main focus on marine transport and manufacturing, off-shore oil and gas exploration, aquaculture and marine protection services and ocean governance. This invention will further promote beneficiation, investment, technology development and training in the field of fluorspar and other minerals.

In support of the country's mineral value chain, the Minerals Beneficiation Strategy is in line with South Africa's essentially advancing infrastructure including broad transport network such as road, ports, pipelines, information and communications infrastructure, as well as the advanced financial banking system. This concentrated investment will allow the country to have full advantage of value addition programs. In order to achieve goals set out in Integrated Resource Plan (IRP), a more reliable and low carbon energy source, exploration of downstream fluorspar beneficiation as an alternative energy source must be provided, as fluorspar is used in uranium enrichment used in generating electricity for low carbon emission energy.

11. OPPORTUNITIES

South Africa is endowed with vast deposits of fluorspar. The country has the largest single fluorspar reserves globally and the potential to grow its fluorspar resources into fully cohesive fluorine supply chain. However, it exports most of its fluorspar mineral in an unbeneficiated form. This is contrary to Government policy to beneficiate the country's abundant natural resources.

The country is on a drive to use its comparative advantage to grow the local chemical industry of beneficiated fluorochemical products to compete in the global markets. Other areas of opportunities

exist in the manufacturing of fluorochemicals that are critical in the production of agrochemicals, pharmaceuticals, semi-conductors for the electronics industry as well as domestic and industrial refrigeration and air-conditioning. Fluorspar beneficiation has the potential of adding more value to domestic mineral resources ahead of exports, and thus providing the country with greater economic value necessary for industrialization in government's policies.

Despite there being barriers to entry to the fluorochemical industry in terms of the technology involved, the potential for further downstream beneficiation presents attractive opportunities for new entrants into the market. There has been reluctance to invest in the technology and infrastructure required for fluorspar beneficiation owing to several factors, including: skills shortage and the length of time it takes to develop fluorochemical facilities. The challenge facing the industry is to strike a balance between innovation and the commercialisation of that innovation. The value of fluorochemicals generally increases with the complexity of the molecules, the cost of reagents and the difficulty of processing steps require producing the compounds, but all of these can be achieved with the right business models.

The setup of fluorochemical plants in the country aligns with the economies of scale and will have positive knock-on effects on the development of other industries. In a long-run these innovations will address the country's trade deficit in the chemical products and generate employment opportunities.

12. OUTLOOK

The global demand for fluorochemical is forecasted to increase by 3.6 percent per year to 3.8 million metric tons by 2018, which will reasonably spur demand for fluorspar. China will continue to be the largest and one of the fastest growing markets for fluorochemicals, accounting for over 40 percent of global volume demand in 2018, along with India only experiencing more rapid growth.

Fluoropolymers will be the fastest growing product segment, driven by expanding opportunities for high-performance materials in the motor vehicle, chemical processing, electronics and coating markets. Demand will be mainly driven by increased use of aluminum as an alternative to steel in cars and light trucks, which results in an increased consumption of aluminum fluorite and positively impacting inorganic fluorochemicals. Rising production of semiconductors, advanced batteries and other electronic components will fuel the demand for fluorochemicals. Despite strict, on-going regulations, fluorocarbon demand will continue to increase at a healthy pace, reflecting a strong demand for air conditioning and refrigeration equipment, especially in the developing world. However, faster growth will be limited by the development of fluorocarbon alternatives and the efforts by a number of developing countries to begin implementing Montreal protocol.

The global fluorochemicals market is expected to reach $ 25 billion by 2020. The demand for fluorspar relies on the production of iron, steel and refrigerants. According to the *Grand View Research Inc.* positive demand of fluorochemicals from key application markets such as refrigeration, aluminum, steel and electronic consumable is expected to drive fluorochemicals sales over the next six years. Trade

patterns and supply bases are changing in the fluorspar industry, thus posing an impact on market participants which are finding it difficult to curtail costs and maintain profitability. Additionally, a very stringent and dynamic regulatory scenario, pertaining to the ozone depleting nature of fluorocarbons has resulted in increased R&D spending to develop environment friendly products.

South African fluorochemicals industry is in its relatively infant stages. Regulation of the industry threatens growth, but the country's transition to a knowledge based economy will accelerate development in the industry. By adhering to the environmental regulations, South Africa solidifies its position and potential in the industry as a whole. Although the country is yet to fully enjoy the benefits of large fluorspar reserves, nurturing of infant industry will yield higher future benefits. Investing in the chemical industry will lead to accelerated economic growth and employment opportunities.

According to the NDP, the manufacturing sector has substantial direct employment creation potential and stimulating the economy at large, by 2020 contributing substantially to the NGP goal of 5 million jobs. Further developments in the BRICS countries fluorochemicals industry will result in the country solidifying its role on the international market and an indispensable role as a driver of innovation.

Despite positive demand outlook, environmental regulations also threaten South Africa's supply of fluorochemicals and fluorocarbons. However, the country can make great strides by investing in environment friendly alternatives. Furthermore, demand for fluorspar will be driven by the deployment of additional nuclear power plants, when South Africa decides to add this type of power source to its local energy mix.

Green economy is definitely the future of fluorspar. South Africa has a unique opportunity to create jobs on scale and address the concerns of climate change, through a partnership to promote the green economy and technologies that allow cleaner production processes to green the economy. The increase in the rate of employment will further increase fluorspar production thus impelling prices to reach sound levels and boosting demand. The green economy concept is an alternative paradigm that offers the promise of growth while protecting the earth's ecosystems and, in turn contributing to poverty alleviation. One of the main benefits of adopting a green economy is its potential to alleviate the environmental impact caused by pollution; a benefit that would be felt globally and locally, of which is imperative for fluorspar which produces fluorochemicals that have high global warming potential and fluorocarbons that impacts climate change.

South Africa has insufficient demand for a world class sized fluorochemical hub. However, there is viability of growing fluorspar, with the growing economy and the fact that the country is endowed with the world's largest deposit of fluorspar. Demand will as well increase going forward on the back of economic cycle-related fluorspar trends for more discrete variations caused by commercialization of technological innovations, rapid changes in environmental regulations and government-imposed trade restrictions. There is currently a huge demand for fluorochemicals in Africa and South Africa is well positioned to supply this market through its already established institutions like Pelchem and the existence of niche expertise in the fluorochemicals industry.

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