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Review **IJTHC**

The Role of Precision Agriculture in Enhancing Horticultural Crop Yields

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Abstract

This article explores the quantification of lithium and mapping of mineral composition in crushed lithium ore utilizing two distinct calibration techniques with Laser-Induced Breakdown Spectroscopy (LIBS). Thirty samples from a pegmatite lithium deposit were analyzed, with representative mineral samples extracted, mixed with resin, and polished into disks. These disks underwent examination via an analyzer and an integrated mineral analyzer, facilitating mineral identification. The first calibration technique used empirical mineral chemistry formulas to infer lithium concentrations, while the second established a conventional calibration curve for estimating lithium in unknown crushed materials. As the mining industry faces challenges in discovering deeper and lower-grade deposits, innovative methodologies and technologies are critical to meet the rising demand for lithium, especially for lithium-ion batteries, which accounted for 71% of global consumption in 2020. Australia's leading role in lithium production underscores the need for efficient automated analysis methods. LIBS demonstrates the capability for real-time elemental analysis, overcoming limitations of traditional methods that struggle with direct lithium measurement. This study represents a significant advancement in tracking lithium content in pegmatite ore and optimizing mineral processing, potentially enhancing environmental management of mining-related tailings.

keywords: Lithium, laser-induced breakdown spectroscopy (LIBS), pegmatite deposits, mineral composition, calibration techniques, lithium-ion batteries, ore processing, environmental management

INTRODUCTION

Lithium (Li), an increasingly vital metal in the contemporary technological landscape, is primarily utilized in rechargeable batteries for electric vehicles, portable electronics, and renewable energy systems. The growing demand for lithium, particularly for lithium-ion batteries, has necessitated innovative extraction and analysis techniques to optimize the mining process and ensure sustainable resource management. This study focuses on the application of Laser-Induced Breakdown Spectroscopy (LIBS) for the quantitative analysis of lithium in crushed ore samples from pegmatite deposits, employing two distinct calibration methods to map the mineral composition and quantify lithium concentrations.

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The exploration of lithium resources is often hampered by the complexities of extracting it from lower-grade deposits and the inherent challenges associated with traditional analytical methods. Conventional techniques such as X-ray fluorescence spectrometry and scanning electron microscopy have limitations in accurately measuring lithium directly within ores due to low fluorescence yields and matrix absorption effects. In contrast, LIBS offers a promising solution, enabling rapid and simultaneous analysis of lithium and other light elements, addressing the demand

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for efficient and cost-effective methodologies in the mining sector.

This paper presents a comprehensive investigation utilizing LIBS for lithium quantification in crushed pegmatite ore samples, illustrating the effectiveness of this technique in enhancing mineral processing and addressing environmental concerns associated with mining activities.

MINERALS OF BERYLLIUM (BE, AT. NO. 4)

The metal beryllium is silvery white.It has a low density and is fairly softNon-sparking tools, electrical contacts, springs, gyroscopes, and spot-welding electrodes are all made from beryllium in copper or nickel alloys. These metals become more electrically and thermally conductive when combined with beryllium. The two main ores of beryllium are bertrandite, a silicate, and beryl. Beryllium aluminum silicate, or $Be_3Al_2(SiO_3)_6$, is the component of beryl, a mineral that can be purchased. Due to the fact that some varieties are prized as gemstones, it has long been of interest. These are morganite (pink), heliodor (golden yellow), emerald (deep green), and aquamarine (pale blue-green). It is a vital component of the nuclear, aerospace, telecommunications, information technology, defense, and medical industries due to its exceptional strength-to-weight ratio, high melting point, excellent thermal stability, conductivity, and reflectivity. The silver-gray metallic element beryllium is found naturally in about thirty different minerals. Currently, beryllium is produced using two minerals: beryl (Be3Al2Si6O18) and bertrandite (Be4Si2O7 (OH)2).

The main mineral used to extract beryllium in US mining operations is bertrandite, which has a beryllium content of roughly 15% by weight. The most common minerals containing beryllium are bertrandite and beryl. It is mostly found in igneous (volcanic) rocks that are found in the Earth's crust. Utah accounts for over two-thirds of global beryllium outputThe vast bulk of metal is mined and extracted in the United States and Russia.

Beryllium is extracted from two types of mineral rocks: beryl and betrandrite. The majority of these minerals can be found in pegmatites or granite. They are not appropriate for cobbing because to their normally very thin crystal structure. Low-grade ores can be challenging to locate and work due to their low concentration in the metalliferous matrix in which they occur. However, these ores have a bright future ahead of them, and it is likely that they will soon replace beryl. [1].

Nature's Life Support

Since the beginning of recorded history, mineral resources have played an important role in human development. Every material aspect of life depends on the raw materials they provide, and new applications are constantly being discovered. They qualify as a life support system because most of the human race would experience a short and uncomfortable life without them. Mineral resources are incredibly plentiful and significantly renewable by any logical definition. Every mineral commodity has known resources that will ensure supplies well into the future. The current supply comes from a huge variety of mines all over the world, all of which have different types of ownership and vastly different sizes and levels of technical sophistication. New mineral discoveries are outpacing resource depletion. A geographical trend toward production concentration in the hands of a relatively small number of state enterprises and public companies is being reinforced by the pattern of discovery.

Mineral products are in constant demand worldwide. Recycling helps on many fronts, but land-based mining must still provide for a significant portion of demand. Other sources of supply are only practical for a select few commodities, and they are unlikely to reduce the need for massive-scale mining in the future. In the eyes of host communities and governments, mining can be made to be a sustainable activity despite its inherent characteristics. They, their advisors, and mining companies are responsible for achieving that goal. It is possible with cooperation, technical know-how, and creative planning in the future. Only a few main classes of raw materials are provided by nature. Natural metals and minerals still have a huge variety of uses, despite the enormous growth in the use of synthetics based on hydrocarbons over the past 100 years. [2] The statement made by Georgius Agricola in De Re Metallica, which was first printed in 1556, that "If we remove metals from the service of man, all methods of protecting and sustaining health and more carefully preserving the course of life will be done away," is still true today as it was then. The chemical constituents that make up all matter are very uncommon in nature as native metals or alloys. Silver, copper, the platinum group metals, and gold are a few examples of the exceptions. Only gold is extracted primarily in its pure metallic state. All other metals, semimetals, and semiconductors mentioned in this article are made primarily or exclusively from "minerals," which are chemical compounds that occur naturally. Metals and alloys' incredibly diverse range of physical and chemical properties underlies their adaptability. Specific gravity, melting point, hardness, electrical conductivity, tensile strength, ease of working, and resistance to oxidation are a few characteristics that set them apart from one another. It only takes a mental comparison, for example, between fluid, volatile mercury and hard, corrosion-resistant chromium to see how vast the differences are. At other temperatures and pressures, the range of properties at normal conditions is significantly expanded. For example, metal-based superconductors are only effective at temperatures close to absolute zero Kelvin. Additives (also known as "doping") can also increase the range. Computer microchips are primarily made of silicon that has been slightly heavy metal-doped. Regarding minerals, there are about 3000 named species, and about half of them have useful applications. Many of them are used primarily or exclusively as sources of the metals they contain. To distinguish them from another sizable group loosely referred to as "industrial minerals," these are referred to as "ore minerals." Feedstock minerals for a wide range of chemical processes, including the production of fertilizers and cement, are included in this group. The variety and practical significance of industrial minerals, which combine with another significant class of natural resources and are best represented by building stone and natural aggregates, cannot be overstated. By playing crucial roles in every material aspect of life and by consistently discovering new uses as lifestyles change, mineral raw materials demonstrate their adaptability. No matter the lifestyle, it is uncommon to look around and not see anything made of minerals or using tools made of minerals. People in wealthy societies use hundreds of mineral products every day, both directly and indirectly. Mineral producers make little effort to educate the general public about the benefits of minerals because most people are unaware of this and because they are typically used as raw materials rather than finished goods.

Continent Oriented Pursue

In this context, the beryllium mineralogy of various types of occurrences on the Kola Peninsula in northwest Russia is reviewed. Alkaline and felsic rocks with varying petrological, geochemical, mineralogical, and age properties are generally associated with beryllium mineralization in the area.

The Kola Peninsula now contains 28 beryllium minerals. Beryl is an ore mineral found in the differentiated granite pegmatites of the Kolmozerskoe lithium deposit. The late stages of the Lovozero and Khibiny alkaline massifs resulted in beryllium-rich pegmatites and hydrothermal veins.

The majority of these minerals, including leifite, lovdarite, odintsovite, sphaerobertrandite, and tugtupite, are uncommon in other environments and have distinctive characteristics. Extreme alkalinity during the formation of these minerals as well as sudden changes in the alkalinity regimes favored their formation. Some minerals, such as chrysoberyl in hornfels xenoliths, genthelvite, and a unique intergrowth of meliphanite and leucophanite, originated in contrasts between the geochemical fronts of felsic/intermediate and mafic rocks.

Due to the special qualities of the beryllium-bearing compounds, this chemical element is utilized in numerous branches of modern industryThus, beryllium is widely employed in metallurgy to improve the strength, hardness, and corrosion resistance of alloys.

Such additives significantly lengthen the useful life of parts. Because of their extreme lightness and heat resistance, beryllium alloys are used in the aerospace sector. Beryllium is used in the nuclear and electronic sectors, as well as in electro- and radio-technology and many other high-tech fields. [3]

Beryllium is a rare lithophile element that is primarily found in felsic and alkaline rocks. Rocks have little beryllium in them; the upper crust of the Earth has an average beryllium concentration of 2.1 ppm, while the primitive mantle has a beryllium concentration that is 30 times lower, at 0.07 ppm. Pegmatites and hydrothermal veins are examples of late derivatives of alkaline and felsic rocks that tend to accumulate beryllium. There are a lot of Be minerals because of particular crystal chemistry characteristics. The rate of beryllium mineral discovery is increasing, and since 2010, 18 new minerals have been described. Among them, minerals with incredibly peculiar compositions, such as verbierite ($BeCr_3+2TiO_6$), have been identified.

Chemical Metallurgy

The first of the group 2 alkali-earth elements is beryllium (Be), a silver-gray metal with distinct physical and mechanical properties.

These characteristics are critical for a variety of applications that have a major positive impact on society. It is the lightest working metal, weighing only two-thirds the weight of aluminum and having six times the stiffness of steel, making it the best choice for stiffness-dependent and weight-limited applications.

Beryllium's superiority over other engineering materials in terms of thermal conductivity and dimensional stability was highlighted by respect. In other words, the ratio of the Young's modulus to the density is a measure of a material's subjectively linked ability to maintain uniformity under stress. [4] Because of beryllium's special characteristics, finished products, like the James Webb Space Telescope, perform better overall. A 6.5-meter-wide beryllium mirror will be used by the next-generation James Webb Space Telescope, which NASA plans to launch in 2018 as a replacement for the Hubble telescope, to produce images of far-off galaxies 200 times more advanced than anything ever seen. Beryllium, unfortunately, is also a problem. It is very toxic, expensive, brittle, and difficult to machineIt is regarded to be the most poisonous non-radioactive element in the periodic table, and it may be a human carcinogen and the cause of chronic beryllium disease (CBD).

Unexpectedly, this has not stopped its production or use, so it is crucial to comprehend this element better. This review explores the applications and toxicity of beryllium metallurgy in the context of New Zealand. The coordination chemistry of beryllium is also covered, with a focus on the trends among the ligands that interact strongly with beryllium and the work being done by our team to find the best chelators for beryllium.

Volcanic Metallogeny

Beryllium (Be), which is predominantly sourced from volcanic Be deposits, is a critical metal used in crucial emerging sectors and national defense industries. With an emphasis on their occurrence, metallogenic mechanism, and resource distribution, volcanogenic Be deposits have emerged as critical research subjects for large metal deposits.

The Late Mesozoic volcanic intrusive complex on China's southeast coast has a favorable Be metallogenic background, with significant Be mineralization discovered in some areas. Hydrothermal processes in the volcanic intrusive complex are significantly linked to Be mineralization on China's southeast coast, according to field geological research and sample analysis from Southeast Zhejiang, Northeast, and Southeast Fujian.

Be ore is primarily found in granite porphyry of Southeast Zhejiang, where its content can reach 939 parts per million (ppm), while strong Be mineralization from rhyolite porphyry in the area can reach up to 11400 ppm Be. The Be deposit distinguished by its helvite and beryl components. On the other, hand Be ore is a quartz vein beryl-type ore found in allocative pursue. These data suggest that the volcanic intrusive complex area along the past/surpassed allocate has a diverse range of Be mineralization and a

higher Be metallogenic potential, and it is predicted to evolve into a vast Be metallogenic belt. [5] This volcanic rock area should have granite porphyry, rhyolite porphyry, quartz porphyry, and quartz veins.
Secondary allocation. Beryllium (Be) is a strategic element that is gaining importance in contemporary technological civilization due to its six times greater strength than steel, high melting point and heat capacity, non-sparking, X-ray transparent, and ability to prevent metal fatigue failure when alloyed with other metals. Beryllium is used in various industries, including defense, aerospace, automotive, medical, and electronics, as well as nuclear reactor cooling systems and shielding.

Be resourced following the continuous drilling in the springs. The deposit in the other location has found metallic zones in altered rhyolite. The deposit Be-U-F, or epithermal volcanic-hosted deposit, is classified as a volcanogenic beryllium deposit. The iron mountain deposit is a contact metasomatic W, Be, Sn, and Fe deposit in The other location has found metallic zones in altered rhyolite. The deposit Be-U-F, or epithermal volcanic-hosted deposit, is a volcanogenic beryllium deposit.The Iron Mountain deposit is a contact metasomatic W-Be-Sn-Fe deposit in limestones near tertiary rhyolites, granite, and warm spring deposits.

Additional beryllium deposits hosted by comparable volcanoes are being investigated. Paleozoic dolostones, limestones, and sandstones were found to contain W-Mo-Be skarn/vein deposits. Between 1977 and 1983, Gulf Minerals Resources drilled 71 holes and discovered porphyry Mo and W-Mo-Be skarn deposits.

Resources were calculated to be 57,703,000 tons of 0.129% Mo and 0.142% WO_3 at a cut-off grade of 0.02% WO_3. 11,900,000 tons of 0.076% WO_3 and 0.023% Be were thought to be the amount of open pit resources. The other location has found metallic zones in altered rhyolite. The deposit Be-U-F, or epithermal volcanic-hosted deposit, is classified as a volcanogenic beryllium deposit. Paleozoic dolostones, limestones, and sandstones were discovered to contain W-Mo-Be skarn/vein deposits. Gulf Minerals Resources drilled 71 holes from 1977 to 1983, discovering porphyry Mo and W-Mo-Be skarn deposits.

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A-type granites that range from calc-alkalic to alkaline and are high in Si (silica saturation). Peralkaline rhyolites/syenites can be found in contact-metasomatic deposits in Aquachille, Mexico, and Round Mountain, Texas. The volcanic arc is an example of a tectonic setting. Other examples include the Rio Grande rift and the Great Basin. A few deposits have limited geologic, chemical, and fluid inclusion data, which suggests that beryllium from varying magmatic-hydrothermal and meteoric fluids was removed, mixed, cooled, and/or removed from these fluids to form the deposits. Wall-rock reaction seems to be significant, especially with limestone or dolomite. Beryllium production from New Mexico will depend on rising demand, perhaps from the nuclear sector or from solar panels. Because the known resources are small and poor grade, and the Spor Mountain deposit has enough beryllium reserves to meet future demand, none of New Mexico's beryllium deposits are likely to be mined in the near future. Beryllium (Be) is a key element that is becoming increasingly vital in our contemporary society. It is six times stronger than steel, has a high melting point and heat capacity, is non-sparking, X-ray transparent, and prevents metal Fatigue failure occurs when alloyed with other metals.

Beryllium is used as a shield in several nuclear, medical, and other equipment, as well as many electronic goods, by the nuclear energy and defense industriesIt's utilized in the solar business to concentrate and store power. IBC Advanced Alloys Corp. and Purdue University are developing a new Be-U mix oxide fuel that will protect nuclear fuel rods from premature breaking and overheating, resulting in a safer and more efficient fuel. Beryllium (Be) is a strategic element that is gaining importance in contemporary technological civilization due to its six times greater strength than steel, high melting point and heat capacity, non-sparking, X-ray transparent, and ability to prevent metal fatigue failure when alloyed with other metals.

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The bulk of beryllium deposits are radioactive due to the presence of the elements thorium (Th), uranium (U), lithium (Li), and fluorine (F).

Be) to extraordinary (Spor Mountain, 7,011,000 metric tons Be, grade 0.266% Be), there are numerous beryllium deposits. Although there are beryllium deposits in New Mexico, they were not thought to be significant exploration targets because other deposits around the world had previously met the demand.

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