



## RARE EARTH ELEMENTS

### MINERALOGY, MARKET, AND ASHRAM, A RARE EARTH CARBONATITE DEPOSIT

The rare earth element (REE) space is complex, fascinating, and often opaque. In the industry, the REEs include fifteen (15) elements – lanthanum (La), cerium (Ce), praseodymium (Pr), neodymium (Nd), samarium (Sm), europium (Eu), gadolinium (Gd), terbium (Tb), dysprosium (Dy), holmium (Ho), erbium (Er), thulium (Tm), ytterbium (Yb), lutetium (Lu), and yttrium (Y). These elements almost always occur together within the same minerals, albeit in different proportions, and are therefore processed as a group until eventual separation into individual rare earth oxides (REOs) by solvent extraction. There are over 150 rare earth bearing minerals known; however, only three dominate commercial processing – monazite, bastnaesite, and xenotime. The reasons for this may be attributed to the type of host rock, REE distribution, high REE mineral tenor (>60% REO), and perhaps most importantly, the ability to be cost effectively processed into high-grade mineral concentrate (>40% REO) prior to downstream hydrometallurgical processing.

Initially, REEs were commercially produced from monazite-xenotime mineral sands in India and Brazil; however, through the 1960s and into the 1980s production was dominated by the Mountain Pass Mine, a carbonatite bastnaesite deposit located in California. Much of this initial demand was driven by the onset of colour televisions that required the use of europium (Eu) as a phosphor to provide



the red colour. The dominance of Mountain Pass, however, would not last and China has since grown to be and remains the dominate producer and consumer of REEs globally. In 2019, according to Adamas Intelligence, China dominated the global rare earth value chain with more than 70% of the mining, 85% of oxides, and 90% of metals, alloys, and magnets.

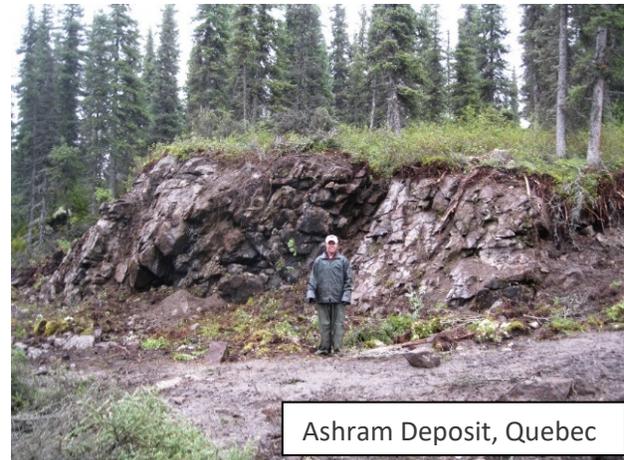
The global need for supply chain diversification and security have led the rare earth market to have a storied past over the last decade, enduring a euphoric price appreciation in 2011/12 to an eventual bubble burst followed by years of falling prices. Prices have since stabilized, with several remaining well above their mid-2000s level. Specifically, those REEs that form an integral part of a permanent rare earth magnet



– Nd, Pr, Dy, and Tb – which are used in a vast array of applications that are essential to our current way of life and clean energy technologies being advanced (wind turbines, EVs, etc.).

Rare earths are not rare because they are hard to find – Ce has a similar crustal abundance to Cu – they are rare because they are very difficult to find in a manner that is economic to extract – cost effective recovery of REEs is a fundamental component to success. This is further emphasized by there being only three rare earth bearing minerals that have dominated commercial production historically and where the host rock type has been dominated by carbonatite – the source for roughly 80+% of current global rare earth production.

The Ashram Deposit, owned by Commerce Resources Corp., is one of the largest rare earth element and fluorspar deposits globally. Located in northern Quebec, the deposit hosts a Measured Resource of 1.6 million tonnes (Mt) at 1.77% REO and 7.7% CaF<sub>2</sub>, an Indicated Resource of 27.7 Mt at 1.90% REO and 5.9% CaF<sub>2</sub>, and an Inferred Resource of 219.8 Mt at 1.88% REO and 4.5% CaF<sub>2</sub>, at a cut-off grade of 1.25% REO. The project has a positive and robust Preliminary Economic Assessment completed in 2012 and is actively advancing through Prefeasibility.



Ashram Deposit, Quebec



Ashram drill core

Being characterized by a comparatively simple rare earth mineralogy (monazite, bastnaesite, and xenotime), carbonatite rock type, good grade, high-tonnage, top jurisdictional location, and a well-balanced REE distribution

enriched in the magnet feed REEs that is significantly higher than top global producers, the Ashram Deposit is a promising potential source of magnet feed REEs to a market in need of a secure and long-term supply.



## **Speaker: Darren L. Smith, M.Sc., P.Geo.**

Darren L. Smith is an M.Sc. graduate of Carleton University (2005) and a Senior Geologist and Project Manager with Dahrouge Geological Consulting Ltd. With offices based in Edmonton, AB and Denver, CO, Dahrouge Geological provides professional geological consulting and project management services, as well as a variety of expertise, to the mining and mineral resource industries over a large array of commodities.



Darren's primary role with Dahrouge Geological is high-level project management to the mineral exploration industry, including program design, implementation, data capture, reporting (NI 43-101, Assessment), land management, corporate disclosure, as well as indigenous peoples and government engagement. Darren has provided technical oversight for Preliminary Economic Assessments as well as Prefeasibility and Feasibility level project advancement and has setup and monitored complex metallurgical programs. Throughout his more than 15-year career, Darren has assisted his clients in the exploration for a variety of commodities. However, his primary focus and interest has been carbonatite complexes and associated metals, including niobium, tantalum, scandium, and rare earth elements (REEs) as well as fluorspar.

In late 2009, Darren and his team discovered one of the world's largest rare earth element and fluorspar deposits (Ashram), located in northern Quebec, Canada, and he has been instrumental in its advancement since this time, including a PEA completed in 2012 and continued work in support of Prefeasibility. During this time, Darren has also developed an in-depth knowledge of the rare earth market and value chain – deposits, producers, processors, and end-users – including personalized tours of the Mountain Pass Mine and processing facilities in California, and Solvay's rare earth processing and refining facility in Larochelle, France.

Throughout his career, Darren has been an invited speaker at several rare earth industry workshops and conferences (Metal Events, Roskill, CanmetMINING, Quebec Mines, CIM) and is active in engaging with institutions in support of various student undergraduate and graduate projects. In addition, through his academic and industry collaborations, Darren sits on several industry and governmental committees and has co-authored several international and peer reviewed publications on rare earth mineralogy and



mineral processing. Darren has also served as Independent Director for several uranium and lithium focused junior mineral exploration companies over his career, and is currently Vice President of Exploration of Gaia Metals Corp. and well as part of the management team for Commerce Resources Corp. and Saville Resources Inc.