Module B. Colour from the Cosmos

Lesson 10 - Diamond Geology and Geography

Where is Diamond Found and Mined Globally?

The current understanding of diamond deposit geology is far beyond that of even 20 years ago. Consequently, the distribution of known diamond deposits is becoming better documented and the exploration for new deposits is rapidly becoming more refined. Recent articles by Groat et al (2012), Read & Janse (2009), Field et al (2008), Stachel (2007), Janse (2007) and Shor (2005) give a very good overview regarding both the science of diamond deposits as well as the commercial side of production.

A histogram of diamond-related research in peer-reviewed publications shows an interesting trend (see below), with pulses of published research in the early 1990's and mid-late 2000's. These pulses probably lag behind times of 'shake up' and 'deregulation' in diamond trade during the mid 1980's (e.g., Argyle and Udachnaya mines) and then the diamond rushes and mine openings in Canada and elsewhere during the late 1990's and early 2000's (e.g., Ekati, Diavik and Catoca). Cutting edge research is used in the diamond industry during exploration and mining, however, publishable peer-reviewed research findings typically lag behind due to confidentiality clauses and as well as access to sites, samples and information. Also influencing the histogram are the International Kimberlite Conferences that are held approximately every 4 years.

Histogram by year showing the distribution of "diamond + kimberlite" related references in the scientific literature.

As we learned in Lession 10.1, diamond-bearing kimberlites occur exclusively in areas with "old" and "cold" Archaen-aged (older than 2.5 billion years) cratonic basement rocks, such as the cratons of the Canadian Shield or the Kaapvaal craton of southern Africa. By focusing on these Archean-aged cratons (sometimes known as Archons) we can draw a map of the most relevant areas with diamond potential.

World map showing distribution of 16 Archean cratons (red) underlain by Precambrian (> 540 Ma; blue) and Phanerozoic (< 540 Ma; light green) crustal basement. From Yoshida (2012).

In earlier lessons we've touched on the fact that many historical diamonds originated from India with Brazil becoming a somewhat significant source in the 18th century, and then of course South Africa's important role in the diamond industry starting in the 19th century. It should be no surprise then that each of these geographical areas have regions of Archean cratons (red)! Following South Africa in the 20th century, significant diamond-bearing kimberlite discoveries were made in Russia, Australia, Canada and other regions of Africa. Many of these are shown on the following map of the world, which also includes major diamond mines and basement rock types. You may notice differences in the two author's interpretations of what are Archean basement (Archon), Precambrian basement (Proton + Tecton) and Phanerozoic basement ('young' rocks) regions.

This map shows the tectonic location of 24 major diamond mines and seven advanced diamond projects. All major mines developed on kimberlite pipes are located within the boundaries of an archon, while those developed on lamproite pipes are located on a proton. Click image to open larger format. (From Read & Janse 2009)

With only ~30 active major mines and advanced projects from primary "in-situ" kimberlite sources in the world, the diamond industry collects the bulk of its rough material from a relatively small number of companies and locations. Particularly notable is the fact that many of the mines are located in Africa, which has a turbulent past and uncertain future stability.

Historically, India was the sole source of diamonds, however, all of these were mined from secondary deposits (we'll learn more about secondary deposits in L15 and L24) and production is thought to only equate to ~10 million carats over its ~4,000 year history. Although this quantity pales in comparison to today's annual global production of around 125 million carats, it is extremely significant because of its historical importance prior to the 18th century and the number of larger diamonds produced (e.g., the Koh-I-Noor). During the exploration of the "New World" by early Portuguese explorers diamonds were discovered in the Minas Gerais region of Brazil. This new source impacted the global industry but was soon eclipsed by the sweeping changes that came with the diamond discoveries in South Africa during the late 19th century.

This discovery of diamonds within their primary geological source rock (i.e., kimberlite) in South Africa, instead of only in secondary alluvial (river) deposits, changed the industry and many believe this shift is the transition to the "modern diamond mining industry". As the volume of newly mined diamonds increased new markets for diamond consumption were also developed and no longer were diamonds held only for royalty and the wealthy.

In fact, diamond production from South Africa reached ~1 million carats by 1872, only 6 years after the first diamond pebble was found on the banks of the Orange River near Hopetown by a farmer (Erasmus Jacobs). This region would eventually become known as the Big Hole, or Kimberley Mine, which was taken over by De Beers Consolidated Mines in 1873. By the early 1900's production in South Africa had increased to ~5 million carats annually from 8 mines and as new mines gradually opened on the African continent annual production was driven to ~15 million carats by 1950. These significant mines include the Premier (opened in 1903, South Africa), Mwadui (1942, Tanzania) and Mbuji Maye (1924, DRC). Later, the countries of Botswana (e.g., Orapa Mine), Namibia (e.g., alluvial and beach deposits) and Angola (e.g., Catoca Mine) eventually opened additional diamond mines and continental production has only increased. Numerous other African diamond-producing countries exist, however, only those mines on primary kimberlite have any significant production.

This chart shows global diamond production by carat weight (not value) from 1870 to 2005 for eight countries, one region in Africa, and all other producers ("Other"). South Africa's early dominance gave way to production from the Belgian Congo in the 1930s, which in turn was eclipsed by production from Russia (Mir, Udachnaya), Botswana (Orapa, Jwaneng), and Australia (Argyle). Click to open larger format.(From Janse 2007)

The opening of the first significant non-African mine, the Mir Diamond Mine in Russia, was in 1957 shortly after its 1955 discovery. Annual production from Mir by Alrosa Mining Corp quickly reached ~5 million carats and by the mid 1970's it was producing nearly 10 million carats annually. This non-DeBeers mine was the first major blow into the previously established and very strong DeBeers monopoly. Following Mir were a series of additional Siberian mines: Udachnaya (1976), Jubileynaya (1997) and Nyurba (2004).

The next significant event in global diamond mining was the opening of the Australian Argyle Diamond Mine by Rio Tinto in 1983 after the discovery of the "non-traditional" diamond-bearing lamproite in 1979. Australia's annual production started at ~30 million carats, a good proportion of the market share by volume at that point but much of those diamonds were of industrial quality (ie, non-gem quality). In fact, in 1994 the Argyle Mine produced 40% of the world's diamonds by volume! This was the second significant shift of DeBeers' global monopoly and together with the Siberian diamonds was a significant shift in the global diamond trade.

Finally, Canada entered the global diamond trade in 1998 with the opening of Ekati (BHP Billiton), followed by Diavik (Rio Tinto) in 2003. Interestingly enough, neither of these early Canadian mines are operated by DeBeers despite intense but unsuccessful exploration by DeBeers in Canada during the previous ~3 decades. Just years after startup, Ekati was producing ~5 million carats annually and Diavik showed similar productions also with ~5 million carats annually after a few years of operation. Since then production has been relatively steady and the diamonds produced from the Canadian mines tend to have a higher average value per carat when compared against other nations with similar production volumes.

By 2006, DeBeers had dropped from 11 major active mines to 7 (South Africa, Tanzania and Botswana), and was competing against 11 other major active mines spread across the globe with significant production volumes and values. DeBeers would later bring the Snap Lake and Victor Projects in Canada to production though neither have been 100% smooth sailing. Despite their reduction in global diamond mining dominance, DeBeers still maintains significant control of the way diamonds are mined, held, distributed, faceted and sold to the end consumer.

These charts compare percentages of world diamond production by country by year in terms of both volume and value. The early dominance of Congo/ Zaire/DRC production is clear when considered by carat weight (top), giving way to Australia, Russia, and Botswana. Considered by dollar value (bottom), however, the alluvial production from West Africa is dominant from 1935 to the early '70s, while the lower value of Australia's production greatly reduces its impact. Canada's role starts in the late 1990's and you can see the relative difference between carat produced and value contributed as compared to other countries (such as Australia which shows the opposite trend).

In 2011, almost 125 million carats of rough diamond were produced globally with an estimated value of $14.4 billion US dollars ). In 2012, production increased to ~128 million carats of rough diamond with an estimated value of $12.6 billion US dollars. The majority of these diamonds originate from Africa (e.g, Botswana, Congo, Angola, South Africa and Zimbabwe) with significant amounts coming from Russia, Canada and Australia. In both 2011 and 2012, over 75% were produced by only 5 companies: De Beers > Alrosa > Rio Tinto > BHP Billiton > Dominion Diamond (formerly Harry Winston Diamonds).

Total cumulative global production of diamonds is estimated to be around 6.5 billion carats, with nearly 15% of this total production from only the last ~5 years.

Pie charts showing the proportional contributions of countries to the global diamond production by volume and value for 2011. Click to see larger format.

Pie charts showing the proportional contributions of countries to the global diamond production by volume and value for 2012. Click to see larger format.