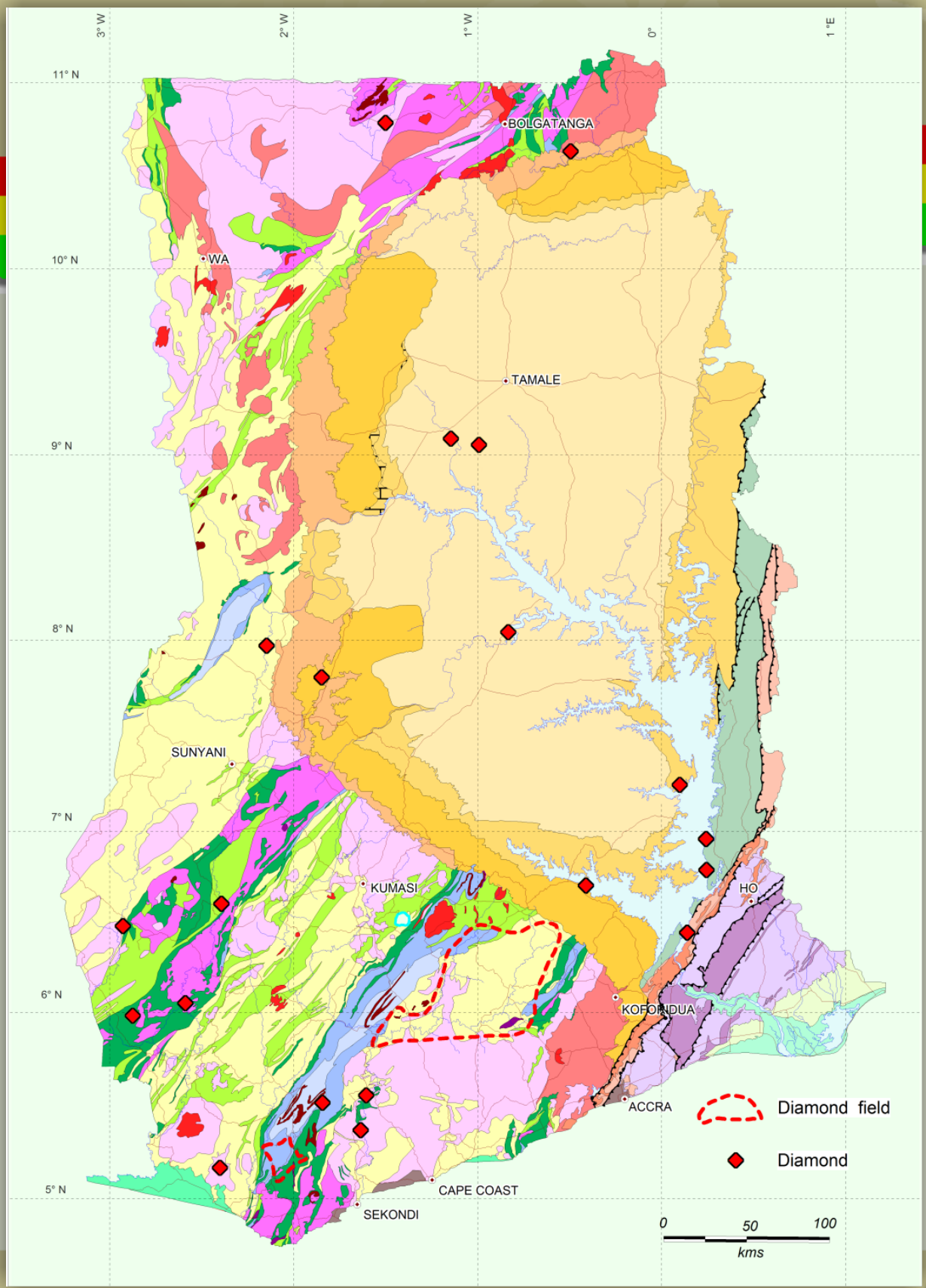
Diamonds Occurrences in Ghana



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INTRODUCTION

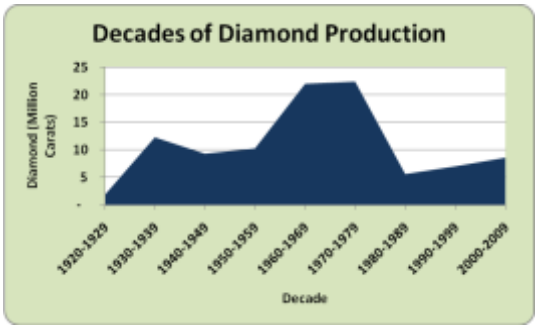
Although gold has been the mineral commodity most associated with Ghana, it is not as well known that diamond production has taken place on a major scale for almost 90 years and that for a period of more than 25 years, from the early 1950s to the late 1970s, Ghana was one of the largest producers in the world. In recent years, production has dropped very substantially, due mainly to the lower prices for diamonds and from the lack of investment in exploration and mining operations. The potential for increased production in established producing areas in southern Ghana remains very high and the potential for important new discoveries in the northern part of the country is intriguing.

HISTORICAL BACKGROUND

On a regional traverse across the northern section of the Birim River Basin in early 1919, the Director of the Geological Survey Dept., Sir Albert Kitson and his colleague E.O.Teale, panned samples from a small tributary to the nearby Birim River, immediately to the east of the small town of Abomosu in what is now the Eastern Region and part of the Akim Abuakwa Traditional Area. Their interest no doubt was in ascertaining whether there was any gold present (there was in minor amounts) and what other heavy minerals could be present as well since these could tell much about the nearby geology. To their considerable surprise, they discovered some very small but well-shaped diamonds, which would have gone unnoticed by less seasoned geologists. They remained at the site for a few days and discovered many more similar crystals and this was the start of quite a remarkable period of diamond exploration and mining that continues to this day.

Within a very few years, diamonds were discovered in many parts of southern Ghana but the most important, by far, were those discovered in the vicinities of Oda, Kade and Akwatia. All of these discoveries were alluvial occurrences and by the mid 1920s, several companies had established operations in the area, which rapidly became a major diamond producer and became known as the Birim River Diamondfield. Since then, the vast majority of production, now close to 150 million carats, has come mainly from this area.

For almost 50 years, the diamond production was dominated by private operators of whom the main company was Consolidated African Selection Trust (CAST), a UK-based company that obtained control over large areas within the emerging diamond field. A competing group, Cayco (London) Limited also obtained a large concession northeast of Akwatia.



The 1950s and 60s saw impressive production from the Birim River area, which averaged over 2 million carats per year from 1963 to 1976. However, despite record production levels, the industry was suffering from high production costs and stagnant prices. Because the industry was considered very important to the national economy, the Government established a new parastatal company, Ghana Consolidated Diamonds Limited (GCD), which took over the troubled CAST operations in 1971. Initially the Government held a 55% interest in GCD with CAST holding the remaining 45% but the latter was sold to GCD in 1982.

Although GCD maintained high production levels until the late 1970s, by the beginning of the 1980s production had dropped significantly to less than 1 million carats per year and by the end of the decade, annual production had faded to less than 300,000 carats. The problem at GCD has not been the lack of known reserves, which remain quite substantial, but rather the lack of new investment and a complete restructuring of the company's operations, which are based in Akwatia. Efforts have been made by successive Governments to privatize GCD on numerous occasions but as yet, a viable partner has yet to be found with the requisite financial and technical skills to take over this challenging but valuable operation.

Over the years, small-scale mining of diamonds has taken place in many areas, especially in the Bonsa Diamondfield south of Tarkwa in the Western Region, as well as along the periphery of the GCD concessions in the Birim River area. During the 1990s up to the present, as GCD has floundered badly, small-scale mining, both legal and illegal, has spread widely throughout the Birim River producing areas. A lot of such activity has actually taken place on areas controlled by GCD, some of it under tributary agreements with GCD, but a lot of it is carried out illegally. With the recent drop in the price of fine-grained diamonds, much of this activity has ceased.

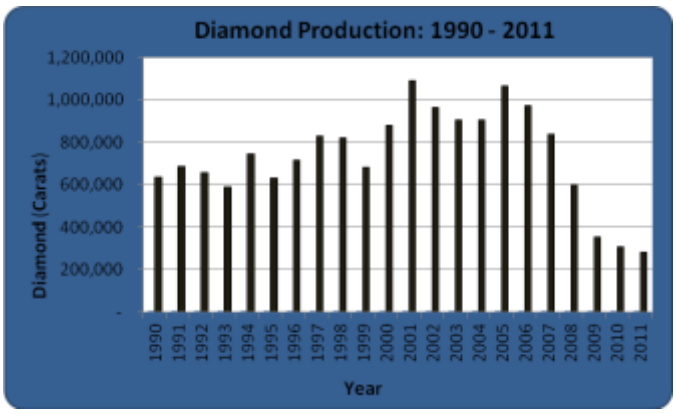
In the mid 1960s, a state corporation, the Diamond Marketing Corporation (DMC), was established by the Government to be the sole purchaser and marketer of diamonds recovered in Ghana. The intent was to reduce smuggling, provide an outlet for small-scale producers, ensure that diamond sales from the larger operations reflected world prices, maintain accurate statistics on production in the country, and allow the Government to obtain a small royalty from the production. Eventually, this state company was replaced by the Precious Metals Marketing Corporation (PMMC) in 1989 with a slightly enlarged mandate to include purchasing of both diamonds and gold from mostly local small-scale operations.

By the late 1990s, other private buyers of precious minerals were allowed to compete with the PMMC and this has no doubt helped to offer competitive prices to local small-scale producers at a time when such mining has been extremely widespread in response to favourable prices in recent years,

especially for gold. With an expected recovery in the worldwide economy, it is also likely that the markets and prices for typical Ghana diamonds will recover substantially and local production will increase accordingly.

PRODUCTION OVER THE YEARS

The following graphs summarize the historical diamond production over the decades. As noted above, Ghana was a significant player on the world scene even though the vast majority of production has been for industrial purposes, especially in the very large markets for abrasives.



BIRIMIAN OCCURRENCES

The majority of diamonds discovered to date in Ghana occur in areas underlain by Birimian metasediments and volcanics but almost all of the diamonds occur in very young (Recent) river bed deposits that overlie the older Birimian units. Whilst the Birim River area is the most dominant producing area, quite a few isolated occurrences have been reliably reported from many other localities in southwestern Ghana, mostly in and adjacent to major volcanic belts (Ashanti, Sefwi, Kibi and Bui). There is also a smaller but significant diamond area just south of Tarkwa, along several tributaries of the Bonsa River.

Within the Birim River Diamondfields, much of the early historical production came from small tributaries over a wide area from Oda northwards to Akwatia and past Kade to Pramkese. The area was studied in some detail by Government geologists (Geol. Survey Dept. Bulletin 12, 1943) and summarized by G.O.Kesse in his very useful book on the Mineral and Rock Resources of Ghana (1985).

The vast majority of the diamonds exported from Ghana have been for industrial purposes and about 80% of them are less than 2mm in diameter. There are occasional stones that may be 1+ carat in size (1 carat is equivalent to 200 milligrams) but far more commonly, 15-50+ diamonds will be required to make up 1 carat. In recent years, production has included recovering the finer grained fractions of the diamonds that were rejected in the past. In addition, the jewelry industry also has become more of a factor than in the past, especially for the well-formed but quite fine-grained crystals, which are very common throughout the district.

In the early days, most of the production came from a large number of small tributary streams, mostly but not exclusively along the east side of the very broad Birim River valley. In many areas, the deposits were shallow (1-2m deep) and occurred over substantial widths (100-300m) along the lengths (several 1000m) of the valleys. The gravels that they were recovered from were often less than 1m thick (range of 30cm-2m) and there was usually 1-2m of barren silty overburden. Most of the resources in these valleys have been mined out.

Eventually, production gravitated towards the Birim River itself, which it was discovered contains very large accumulations of alluvial diamonds. Whilst most of the diamond resources occur along the immediate margins of the river, remnants of older terrace gravels are also known to contain substantial concentrations of diamonds. Within the main river valley, the diamonds occur in much thicker gravels (mostly 1-2m thick) and also have much greater overburden (5-6m). Not surprisingly, the diamonds in these gravels are slightly finer grained than those in the nearby tributaries, which are apparently closer to the original bedrock sources.

For many years, production at GCD focused on the upper part of the Birim River valley from about Kade in the north downstream to the confluence with the Esuboni/Supong, a distance of some 10+ km. These operations required larger equipment (draglines) to strip the overburden and mine the gravels, which were then trucked some distance to the central treatment plant at Akwatia.

Quite substantial alluvial diamond resources occur further downstream in what is referred to as the Middle Birim, which covers approx. 25 km along the valley, past Oda. The Lower Birim area represents a 55+km strip further down the valley to the confluence of the Ofin River. These areas contain substantial established diamond resources, albeit with slightly lower grades than those further upstream and with quite thick overburden (about 6m thick). There had been limited mining in parts of these areas in the past.

Although the Birim diamonds are consistently fine-grained and therefore do not generally command a premium price (20-40 USD/ct), the grades are quite impressive. In the early days of production, many of the smaller tributaries had grades well exceeding 2cts/m^3 and the annual average grades for the first 20 years of production was close to 2 carats/m^3. Naturally, during the later years, the resource grades dropped to just over 1 carat/m^3 and most of the defined resources (perhaps up to 50 million carats) on the Middle and Lower sections of the Birim River have an average grade of 0.6-1.0 carat/m^3.

Not surprisingly, the other heavy minerals associated with the diamonds are dominated by metamorphic minerals such as staurolite, ilmenite, rutile and tourmaline. The typical tracer minerals (pyrope garnet, chromite, chrome diopside and Mg-rich ilmenite) found with many diamond occurrences that are associated with kimberlites and lamproites appear to be entirely absent in any of the Birimian occurrences.

Almost all of the alluvial diamond operations have recovered minor amounts of mostly fine-grained gold. Much of this gold certainly originated from rivers and streams coming off of the nearby Atewa Range, where there are large alluvial gold deposits. However, a modest proportion of the gold has also come from much more proximal quartz vein systems within the immediate vicinity of the alluvial diamond occurrences. It is very difficult to accurately estimate the average gold content in the alluvial diamond occurrences as it will be quite variable from area to area but it will probably be in the range 100-200 mg/m^3. Some deposits closer to the Atewa Range, or other known areas with bedrock gold occurrences, will have higher grades.

There is a fascinating but as yet unclear story as to the origin of the Birimian diamonds. It seems unlikely that they were formed in the conventional environment for diamonds, which include kimberlite (or lamproite) hostrocks that entrain the diamonds from great depths (approx. 150km) beneath thick, cold continental crust. In the case of SW Ghana, there is very little evidence that there was ever any thick continental crust underlying the Birimian belts and basins. Furthermore, there are no known tracer minerals typical of kimberlites and no Birimian-age kimberlites have been identified in the region.

In the area to the immediate south of Akwatia, there are some known occurrences of an ultramafic rock, now consisting mostly of fibrous amphiboles, that has been demonstrated to contain diamonds. Within the same general area, there are also several well-established sites where local small-scale miners recover substantial diamonds from thin bands of highly weathered Birimian metasediments. The latter are distinctive and feature a variety of coarse, elongate clasts or lapilli and they could well have been pyroclastic depsosits or possibly poorly sorted clastic breccias derived from a nearby bedrock source. These ultramafic and unusual clastic units are almost certainly the source of the alluvial diamonds found in the river beds in this area.

The ultramafic (19-22% MgO) rock remains a bit of a mystery as it has affinities with kimberlite and lamproite, the two most common igneous hosts for diamonds, but it also has clear dissimilarities with these rock types. There are geochemical features that seem to fit certain types of lamprophyres and also komatiite rocks, which are essentially ultramafic/peridotite volcanic flows. The latter seems a good candidate as a means to bring up diamonds formed at great depth, especially in view of the oceanic tectonic setting and architecture of the Birimian belts and basins.

A plausible model could envision the diamonds being formed about 2150-2200 million years ago as the result of the subduction of Birimian oceanic crust with a thin layer of organic-rich carbonaceous sediments, which are widespread in the region, and at the right P-T conditions, small diamonds would form within the metasediments on the surface of the subducted oceanic slab. The diamonds would subsequently be entrained by ultramafic magma formed deeper within the asthenosphere and which would rise rapidly to the surface where it could flow out onto Birimian volcanic and metasedimentary terrain or, if the volatile content was sufficiently high, it could erupt as the contained gases exploded at surface to form pyroclastic deposits. Needless to say, much more field mapping and research is required to substantiate the origin of these diamonds and their source rocks.

Although this process appears to have been most widespread in the vicinity of Akwatia, along an extension of the Kibi greenstone belt, it also occurred at many other locations in SW Ghana, which explains why similar diamonds have been found in other greenstone belts in Ghana, as well as in similar Birimian environments in neighbouring Cote D'Ivoire. Within the Ashanti Belt, the main concentration of diamonds in tributaries of the Bonsa River south of Tarkwa seem to have originated from the lower units of the thick Tarkwaian clastic sequence and much further north along the same belt, quite a few diamonds have been associated with the same units. These probably originated in similar ultramafic and/or pyroclastic hostrocks as those observed in the Akwatia area.

OTHER OCCURRENCES

There has long been evidence of younger and much better quality diamonds in central and northern Ghana. In 1919, sampling of stream sediments within the Volta Basin by the Geological Survey discovered some small diamonds in areas that are now inundated by Lake Volta. Later work (1936) by CAST along the Afram River, near Mankrong, discovered more diamonds that were better quality and quite different than those from the Birim River area. These streams were draining an area where basal units, including conglomerates, of the Volta Basin were exposed and the inference was that the diamonds probably came from the Voltaian conglomerates. In the 1923-24 Annual Report of the Geological Survey, an isolated diamond was reported to have been found in a stream between Wenchi and Kintampo in an area also underlain by basal clastic units of the Volta Basin.

In 1936, CAST prospected areas along the White Volta River in the far north of the country and they discovered two large diamonds (7.5 and 10.5 carats) in the gravels close to Gambaga where there is a prominent escarpment comprised of Late Proterozoic clastic sediments overlying Birimian basement units. These clastic units include the basal sections of the Volta

Basin, which is from where the diamonds were probably eroded. Further prospecting and bulk sampling in the immediate area did not result in additional discoveries. There was also no report on other tracer minerals in the same area that could have suggested a kimberlite source for these larger diamonds but, at the time, they were probably unaware of any such association since little was then known of the geochemistry of kimberlite and associated rocks.

Elsewhere in West Africa, there is good evidence that most of the important diamonds (Guinea, Sierra Leone, and Liberia; all of which occur in areas with older Archaean crust) are closely associated with kimberlites formed in the Cretaceous (80-140 Ma) and almost certainly linked to crustal fracturing related to the opening of the early south Atlantic Ocean. However, there is also evidence that some kimberlites in West Africa may have also formed at around 1100 Ma and about 1500 Ma. Certainly in the case of Ghana, by Middle Proterozoic time (approx. 1500 Ma), the continental crust was very thick and probably favourable for the development of kimberlites and there was no shortage of suitable graphitic Birimian metasediments, which could be the source material for diamonds. Since the earliest clastic units in the Volta Basin are probably around 1000 Ma, it is quite possible that diamond-bearing kimberlites did form in various parts of the West African craton prior to this time and they were subsequently eroded and re-distributed into Late Proterozoic clastic units, such as the Volta Basin, which covered almost the whole region.

Later events in Ghana may also have been favourable for the development of diamond-bearing kimberlites, especially in the break-up of the supercontinent Gondwana, starting around 120 Ma when West Africa and South America started to part ways. By this point, West Africa was a thick, cold continental block and deep-seated dilational structures formed by the separation of the continents could provide channelways for kimberlitic intrusions that entrained diamonds from sources in deeply buried Birimian metasediments.

EXPLORATION POTENTIAL

There are many areas in southern Ghana where Birimian diamonds are fairly widespread and remain good exploration targets. Of course, the margins of the Birim River are especially prospective and certainly many of the known areas within the general Akwatia-Oda-Kade district still contain significant resources of alluvial diamonds. Once the diamond markets recover, it is likely that production from traditional small-scale operations will increase and there is little question that the areas still being held by GCD host large alluvial diamond resources that could be developed profitably on a much larger scale. GCD remains an attractive takeover target for a mining group with sufficient capital and technical expertise to do justice to the potential of the established downstream resources along the Birim River.

It is also likely that local artisanal miners will continue to discover and develop new occurrences of diamonds in Birimian metasediments. To date, these occurrences are too small to develop on a large scale but that possibility still exists for future explorationists. More interesting for larger exploration groups will be the potential to discover low-grade but large sources of diamonds in Birimian ultramafic source rocks. The enigmatic ultramafic rocks south of Akwatia have never been explored in much detail and their nature and potential are intriguing. Similar diamond-bearing ultramafics could well be present in the Ashanti Belt, which has many known diamond occurrences, and the Sefwi Belt has quite a few isolated diamond occurrences that probably originated from similar ultramafic Birimian source rocks.

Northern Ghana also has some very interesting potential for diamonds. The two large, good quality diamonds (see above) discovered in gravels of the White Volta, just to the north of Gambaga, appear to have come from basal units of the Volta Supergroup. Also, numerous reports of non-Birimian types of diamonds within the Volta Basin drainage system confirms that there are likely to be post-Birimian, pre-Voltaian sources of diamonds in the region. Furthermore, kimberlites could have intruded during the very lengthy period that the Voltaian sediments were being deposited and subsequently eroded into younger Voltaian clastic units. These possible sources in northern Ghana warrant far more attention.

The new geological map of Ghana (1/1,000,000 scale) highlights the presence of swarms of mostly north trending (with a subordinate but prominent ENE set) dolerite dikes that can be traced from the southern coastal area to the northern border area. These dikes are post-Voltaian and related to the Mesozoic break-up of Gondwana, which led to the separation of West Africa from NE Brasil and the neighbouring countries. Some of these structures may have been initiated along older, N-S structures inherited from earlier Birimian/Eburnean events. It may also not be entirely coincidence that the ENE dikes trend parallel to eastern Atlantic Ocean transform faults, some of which will be quite old. These major structures will certainly extend to very great depths through the thick continental crust and they could be effective conduits for kimberlites, which could entrain deeply buried diamonds from within the Birimian basement.

The recent geological mapping and airborne geophysics over much of the Volta Basin, as well as parts of the eastern border area with Togo, have highlighted the presence of ENE structures that may also be a reflection of the effects of the Atlantic Ocean transform faults that are prominent along the coast of West Africa. Elsewhere, especially in southern Africa, a strong case has been made that correlates extensions of oceanic transform faults onto old cratons with kimberlite intrusions. Very possibly the same association could be present in Ghana and it should be noted that in Togo, along the border

with Ghana between approx. Jasikan and Nkwanta, quite a few small alluvial diamonds have been reported, including a very large 37 carat stone discovered in 1990. On the Ghana side of the border, a few isolated diamonds were reported many decades ago, along portions of the lower Volta River that was later inundated by Lake Volta.

The source rocks for these diamonds have never been discovered and could be from Late Proterozoic to Late Mesozoic or even Tertiary in age. It is interesting to note that on the Ghana side of the border, the recent airborne geophysics shows a cluster of ENE structural lineaments on the west side of Lake Volta that could be extensions of transform faults; several of the major streams, such as the Sene and Obosum, clearly reflect these structures. This structural/tectonic environment would seem conducive for the development of kimberlites that could be the source rock for the diamonds in this region.

It should be noted that in Canada and the northern US, the presence of isolated diamonds in glacial deposits at many locations along the Great Lakes was well-known for over 50 years before the source rocks were discovered in northern Canada in the 1990s. Now Canada is one of the largest producers of high quality diamonds. Sustained exploration in northern and eastern Ghana could discover the sources for some of the isolated but high quality diamonds that have been discovered in the region.