

# Sparklers in the ice

THE ANTARCTIC MAY TURN OUT TO BE RICH WITH DIAMONDS, SAYS S ANANTHANARAYAN

**D**iamonds, valued for their lustre in jewellery and for their hardness and as a conductor of heat in industry, are found mostly in Africa, India, Australia and South America. Now, rocks that could contain diamonds have been found in Antarctica. This discovery suggests Antarctica also formed part of the ancient *Gondwana*, to which the other landmasses once belonged. But finding diamond-rich veins in Antarctica may not lead to a miners' rush, both because of an international accord and also because of the difficult working conditions.

Gregory M Yaxley, Vadim S Kamenetsky, Geoffrey T Nichols, Roland Maas, Elena Belousova, Anja Rosenthal and Marc Norman from institutes in Australia report in their article in the journal, *Nature Communications*, the discovery of *kimberlites*, the classic rock from which diamond is extracted, in the Prince Charles

Mountains in eastern Antarctica. "The samples are texturally, mineralogically and geochemically typical of Group I kimberlites from more classical localities," say the authors, which indicates that the Antarctic was part of the supercontinent that broke up to form the main land masses of the southern hemisphere.

Diamond is a crystalline variety of ordinary carbon, or graphite, but which is quite unlike the common forms of carbon. The diamond crystal consists of tetrahedrons of carbon atoms, securely bound to each other by shared outer shell electrons. As the carbon atom has four outer shell electrons, bonding with four other atoms gives each atom a saturated shell of eight electrons and the structure has unequalled stability, strength and hardness. The structure also results in properties of transparency and very strong bending of light. This, along with many reflecting planes and surfaces, gives diamonds their legendary sparkle and iridescence. The structure and the hardness also permit easy transfer of mechanical disturbances, which makes a diamond the best known natural conductor of heat. These properties, of hardness and heat conduction, make diamonds valuable in industry, apart from the traditional leadership in jewellery.

The way diamonds are formed is when carbon is subjected to very high pressures of 45,000-60,000 atmospheres, at a temperature of 900-1,300° Celsius. This temperature and pressure are found naturally only at 140-190 km underground, in the earth's mantle, below the continental plates, or when a meteorite strikes the earth. While diamonds can thus form in quantity deep underground, the conditions required are best met under the thick, ancient and stable parts of the continental plates. And the diamonds that have been transported to the earth's surface are generally a billion to 3.3 billion years old.

Diamond-bearing rock rises from the earth's mantle to the surface through deep volcanic eruptions. The origin of the eruptions needs to be from three times or more than the depth of the source of most volcanoes. These are quite rare and the typically small surface craters of volcanoes of this group extend downwards in

formations known as *volcanic pipes*. And not all volcanic pipes contain diamonds and of the few that do, only a proportion contains enough



for mining to be economical. The picture shows the section of a volcanic pipe, with the depths where diamond-bearing rock is mined at Kimberley, Jagersfontein and Opara in South Africa. The town of Kimberley, incidentally, lends its name to the form of rock in which diamonds are found.

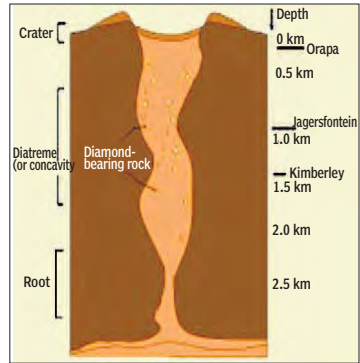
### Kimberlites

Kimberlites are igneous rocks, or rocks formed by the cooling of magma, the molten mineral matter that rises from volcanoes, and are best known because they sometimes contain diamonds. Although they do not form a large part of volcanic rocks, they are studied because they arise from greater depths than other forms of igneous rocks, a conclusion from their lesser content of silica.

Kimberlites are thus the most deep-under-the-earth-derived materials accessible. Their study may hence help understand the composition of the deep mantle and the melting processes between the earth's rocky outer surface and the relatively fluid underlayer.

Kimberlites have been found in almost all stable and rocky formations, below younger sedimentary rock, in all continents, with the exception of Antarctica. It is now accepted that the continents formed by the separation of parts of the ancient *Pangean* supercontinent, the first landmass, surrounded by *Panthalassa*, the single ocean. The first part to break away was the North American continent, with the formation of the Atlantic Ocean, some 175 million years ago, leaving Pangea as *Gondwana*. Later, in the early *Cretaceous*, or some 150 million years ago, *Gondwana* broke up into South America, Africa, Australia, India and Antarctica, or the major part of the southern hemisphere — India, Madagascar and Antarctica having first formed a combined landmass.

The current theory of *continental drift*, for the formation of the continents, was proposed in the early 1900s and is supported by biological evidence. Many of the same life forms, both plant and animal, are found in parts of Australia, India, Africa and South America, which proves that they were once interconnected. The fact that they all contain kimberlite, which has origin deep within below the surface and in great antiquity, is also evidence of the continents having once formed the same landmass.



### Antarctica

While there is evidence of Antarctica having been part of the portion that broke away from *Gondwana*, before separating from India, the presence of kimberlites had not been proved in Antarctica. The article in *Nature Communications* now describes detailed analysis of the composition of the mineral discovered in Antarctica, which shows that it is the same variety of kimberlite as found in other continents. The location in Antarctica also tallies with the mechanism proposed for the rifting that brought about the separation from the Indian subcontinent.

While the discovery of kimberlite and, hence, diamonds in Antarctica may suggest that leaders in the diamonds industry would rush to the South Pole for mining, mining in the Antarctic is forbidden till 2041 under the Madrid protocols, where the nations of the world designated the Antarctic as a "natural reserve, devoted to peace and science" and specifically prohibited mining. Considering the difficulties in attempting to mine the frozen desert that is Antarctica, it is likely that the same prohibition would be extended beyond 2041 as well.

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## EVOLUTIONARY ORIGINS

TAPAN KUMAR MAITRA  
EXPLAINS THE ENDSYMBIOTIC THEORY AND THE SPAWNING OF MITOCHONDRIA AND CHLOROPLASTS FROM ANCIENT BACTERIA

**T**he debate on the evolutionary origins of mitochondria and chloroplasts has a long history. As early as 1883, Andreas FW Schimper suggested chloroplasts arose from a symbiotic relationship between photosynthetic bacteria and non-photosynthetic cells. By the mid-1920s, other investigators extended Schimper's idea by proposing a symbiotic origin and their ideas encountered ridicule and neglect for decades — until the 1960s when it was discovered that mitochondria and chloroplasts contain their own DNA. Further research revealed that mitochondria and chloroplasts are semi-autonomous organelles that can synthesise protein and divide on their own and contain not only DNA but also mRNA, tRNAs and ribosomes.

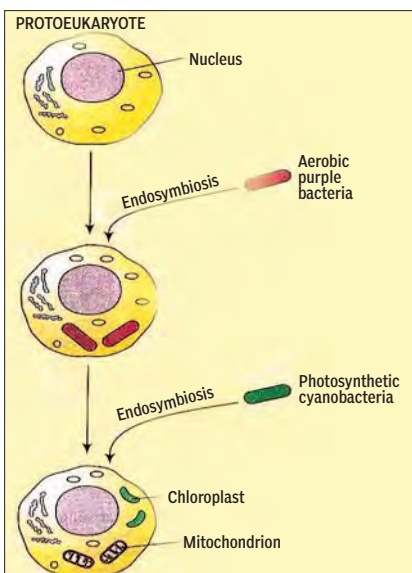
This gradual realisation led biologists to formulate the endosymbiont theory, developed most fully by Lynn Margulis, which proposes that mitochondria and chloroplasts evolved from ancient prokaryotes that established a symbiotic relationship (a mutually beneficial association) with primitive nucleated cells one to two billion years ago.

A preliminary assumption of the endosymbiont theory is that the absence of molecular oxygen in earth's primitive atmosphere limited early cells to *anaerobic* mechanisms for acquiring energy. A few anaerobic cells subsequently developed pigments capable of converting light energy to chemical energy, allowing them to use sunlight as a source of energy. The first photosynthetic organisms probably used hydrogen sulfide or molecular hydrogen as electron donors, but some of their early descendants developed mechanisms for using water as an electron donor. As a result, oxygen was released as a by-product and the composition of earth's atmosphere was dramatically altered.

As oxygen accumulated in the atmosphere, some anaerobic bacteria evolved into *aerobic* organisms by developing oxygen-dependent electron transport and oxidative phosphorylation pathways. At this point, the stage was set for the emergence of eukaryotic cells. The endosymbiont theory suggests that the ancestor of eukaryotic cells (called a *protoeukaryote*) developed at least one important feature distinguishing it from other primitive cells: the ability to ingest nutrients from the environment by *phagocytosis*. This characteristic enabled protoeukaryotes to establish endosymbiotic relationships with primitive bacteria.

How these primitive cells acquired a membrane-bound nucleus is still unclear. The nuclear envelope may have originated from the plasma membrane by endocytosis. The first step toward the evolution of mitochondria may have occurred when a protoeukaryote ingested smaller aerobic bacteria by phagocytosis. Some scientists believe that prior to this event, protoeukaryotes were anaerobic and depended entirely on glycolysis for energy.

The ingested aerobic bacteria, with their electron transport and oxidative phosphorylation pathways, would have provided larger amounts of useful energy than the protoeukaryotic cell could produce by glycolysis alone. In turn, the host cell provided protection and nutrients to the bacteria residing in its cytoplasm. The ingested bacteria and the protoeukaryote, which both benefited from the association, established a stable symbiotic relationship. As the cytoplasmic bacteria and host cell adapted to living together over hundreds of millions of years, the bacteria gradually lost functions that were not essential in their new cytoplasmic environment and developed into mitochondria.



Major Events That Might Have Occurred During the Evolution of Eukaryotic Cells. Considerable evidence exists for an endosymbiotic origin for mitochondria and chloroplasts. Most biologists agree that the primitive cells that were ingested by protoeukaryotes and then evolved into mitochondria and chloroplasts were, respectively, purple bacteria and cyanobacteria. This is based on similarities in size and membrane lipid composition, comparisons of rRNA base sequences, the presence of circular DNA molecules, and the ability to reproduce autonomously.

To determine what kind of bacterium might have been drawn into this scenario, the base sequences of contemporary mitochondrial ribosomal RNAs (rRNAs) have been compared with the base sequences of various bacterial rRNAs. The closest matches occur among *purple bacteria*, suggesting that the ingested ancestor of mitochondria was an ancient member of this group.

The endosymbiont theory is based primarily on biochemical similarities observed among mitochondria, chloroplasts and bacteria, but support is also provided by contemporary symbiotic relationships that resemble what might have occurred in the distant past. Algae, dinoflagellates, diatoms and photosynthetic prokaryotes live as endosymbionts in the cytoplasm of cells occurring in more than 150 different kinds of existing protists and invertebrates. The cell wall of the ingested organism is often no longer present, and in a few instances the cell structure is even further reduced, with only the chloroplasts of the endosymbiont remaining.

A striking example of endosymbiosis occurs in certain marine slugs and related mollusks, where the cells lining the animal's digestive tract contain clearly identifiable chloroplasts. These chloroplasts originate from the green algae the mollusks feed on and continue to carry out photosynthesis long after being incorporated into the animal's cells.

In the final analysis, our ideas about how eukaryotic cells acquired their complex array of organelles over billions of years of evolution must remain speculative because the events under consideration are inaccessible to direct laboratory experimentation. However, one of the strengths of the proposed role of endosymbiosis in the evolutionary origins of eukaryotic organelles is that it involves interactions and events that are observed in contemporary cells.

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## Import of being connected

TECHIES IN LOVE WITH CYBERSPACE NOW HAVE THEIR OWN FESTIVAL TO TEST THE LIMITS OF LEARNING AND EXPLORING, WRITES SUBHASIS CHATTERJEE

**T**he Hackathon DevFest is meant for techies who swear by the internet and like to explore cyberspace for its full potential. In September, when Google Developers' Group, New Delhi, showed an interest in being part of the fest, it offered three brand new Google Nexus 7 tabs for the winners. Quite swiftly, Google roped in David McLaughlin (Global Programmes Lead, Developer Relations, Google) to entice developer junkies of northern India and coined the programme "Breakfast with David McLaughlin".

Since then, the GDG has been a platform that technology enthusiasts and techies look up to for showcasing talent. The latest DevFest organised by GDG was held in Kolkata and saw some eager talents emerge. Technology enthusiasts from outside West Bengal made full use of the global attention, too. If GDG, Delhi, owes it to Raveesh Bhalla, or GDG, Hyderabad, to Uttam Tripathi for its popularity, the Kolkata chapter had techies like Suvankar Bose and Koushik Pal to spearhead its presence in the city. Both professionals have been among those that contribute to the formation of several open source sharing groups. Says Pal, "Being involved with the group, we felt the need to bring the concept to Kolkata and we must say the response was overwhelming."

Indeed, the recent two-day fest — focusing on web application development, mobile application development, and knowledge sharing — received overwhelming response from across the country. "The vision and mission of GDG is to bring like-minded people together under one umbrella. It means people who are truly passionate about Google's developer technology and interested in communicating, collaborating and developing useful applications like Android, App Engine and Google Chrome platforms to product APIs," says Bose.

The GDG is currently present in 100 countries and has 430 chapters, both active and incubating. It has been organised in several Indian cities and aims at organising tech discussions, seminars and Hackathons to encourage networking and establish a rich and active developer community worldwide.

"At GDG DevFest, we talk about Google products and how techies can use them to share, collaborate, create and do what they love most," says Pal. In India there are many enthusiastic students who do not get enough exposure and encouragement.

The GDG chapters aims at bridging that gap.

Participant Jaipradeesh came all the way from Thanjavur in Tamil Nadu to attend the Kolkata fest. Soumya Deb came from Pune. Says Priyanka Banerjee, an active member of GDG, "It's great to be involved with GDG where all open source contributors are free to join. Google gives you the freedom to work." Her responsibility as a GDG member is to spread awareness of the Internet and technology.

For Pratik Kumar, a first-year IT student of Jadavpur University, it has been a long struggle to reach the stage where he now finds himself. He dreams of a future where he will be able to contribute to India's development with the help of technological innovations. He's had a roving life as far as his academic career is concerned, due to his father's frequent transfers. When in Jamshedpur as a senior student, a truck accident left him with his left leg extensively damaged. After months of medical treatment, he was finally able to walk again. Meanwhile, he cleared his exams with good results from a hospital bed. Kumar is a good swimmer and plays cricket too. "I know someday I will be successful because of the mental toughness and determination I have."

At Jadavpur University, he was introduced to the GDG concept by Jitesh Choudhary, Google Students Ambassador, Jadavpur. After attending the GDG, Pratik found that "the range of technologies which were covered was unmatched. From Google apps to Google Chrome, to web apps to mobile apps to Android system and many more, everything was covered in that event. And all the technical misconceptions all of us usually have and live with it were cleared by professionals."

Organiser Pal himself is a beneficiary. "I hail from smalltown Bolpur. When I was a child, not many people could understand my passion towards computers. But that didn't deter me and today I am a GDG manager," he says with satisfaction.

TRANS WORLD FEATURES



Suvankar Bose and Koushik Pal.

### PLUS POINTS



### Overdose & antidote

Researchers say patients with paracetamol poisoning could be helped by a new way of delivering an antidote. Treatment with the common antidote remedy — acetylcysteine — over a shorter time period than currently applies leads to fewer side-effects, according to a trial study published in the *Lancet* and carried out with the Universities of Newcastle and Aberdeen. Patients are normally given the drug by intravenous drip over a 21-hour period, with a large part of the dose given very quickly. In a study, patients who received the same dose of acetylcysteine more gradually over a 12-hour period experienced less vomiting and fewer-associated reactions. Their treatment was also less interrupted than those receiving conventional treatment with a 21-hour drip.

Professor Nick Bateman, of the University of Edinburgh's BHF Centre for Cardiovascular Science, said, "Our finding offers a major advance in treating paracetamol poisoning, both in terms of fewer unpleasant side-effects for patients and a shorter hospital stay. We need to do more work on a larger population group to find out whether treatment over a shorter time frame is as safe as the current standard."

### Just got better

Dogs can predict and understand human behaviour better than ever, a new study has found, suggesting future generations of man's best friend may not need any training at all. The University of Abertay, Dundee, study found that a dog's understanding of our minds is increasingly instinctive, as is the ability to predict the desires and reactions of its human "pack leader".



It analysed the behaviour of 24 dogs — some highly trained, some not tutored at all — and found that the level of coaching a dog had received made no difference to its reaction to unspoken commands, such as pointing or nodding for it to change location. And with selective breeding showing no signs of slowing down, that trend is likely to continue, as more intuitive dogs are encouraged to breed with those of a similar intelligence.

Dr Clare Cunningham, who led the study, said, "We found that training levels didn't make any difference — no matter how well trained they were, it did not make their ability to pick up cues better or worse."

JOHN HALL/THE INDEPENDENT

### Good news & bad

The volume of sea-ice floating in the Arctic Ocean increased by about 50 per cent in October compared to the same period of 2012, which was one of the lowest on record, according to scientists. Europe's CryoSat satellite, which is designed to monitor sea-ice thickness, measured about 9,000 cubic km of it in October 2013, a notable increase compared to the 6,000 cubic km seen in October last year.

They said the rebound probably marked a temporary respite for the polar region, which has seen dramatic



A photograph supplied by the National Oceanic and Atmospheric Administration shows Arctic sea-ice in 2013.

and long-term changes in recent decades due to regional warming that has melted Arctic ice on both land and sea. The extent of the surface area covered by sea-ice — measured by a different satellite — also saw an increase on the previous year; however, it was still the sixth lowest since satellite records began in 1979. The seven lowest recorded sea-ice extents have all occurred in the last seven years.

But David Kennedy, deputy under-secretary for operations at the US National Oceanic and Atmospheric Administration, said, "The Arctic caught a bit of break in 2013 from the recent string of record-breaking warmth and ice melts of the last decade. But the relatively cool year in some parts of the Arctic does little to offset the long-term trend of the last 30 years: the Arctic is warming rapidly."

STEVE CONNOR/THE INDEPENDENT