Be that as it may, the results reported from the laboratory of Isner are indeed exciting because of the wide spectrum of potential clinical application. The important question is whether the increase in perfusion achieved by angiogenesis induced by intramuscular transfer of VEGF will last long.

Early this year, yet another advance was reported, strategically significant for therapeutic angiogenesis[13]. From human blood, using magnetic beads coated with antibody to CD34, mononuclear blood cells which differentiated and proliferated under tissue culture conditions have been harvested. These cells stained positively for markers such as Factor VIII, endothelial constitutive nitric oxide synthase and E-Selectin. Thus, they have been identified as endothelial cell progenitors or angioblasts. In animal models with hind limb ischaemia, when these cells were administered into the tail vein, the cells integrated into capillary vessel walls. New blood vessels were observed on histological examination of ischaemic limb, 1–6 weeks later.

These findings imply that angioblasts isolated from the blood of patients, themselves may be used to promote vascular growth and also as vectors to deliver angiogenic factors.

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Birth and growth of early continental crust

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The present configuration of Earth's continents is the result of plate tectonic and mantle activities operating over past 4.5 billion years. While we have authentic records for the past 4 billion years, no readily observable crustal growth details in the form of vestigial bits of land or any indirect evidences for earlier continental segments for the first half-billion years are available for geochemists to reconstruct this chapter of Earth's history. The latter, therefore, had remained somewhat enigmatic till discoveries of 4.2 b.y. detrital zircon grains in Australia a few years back, which confirmed the existence of an earlier granitic crust[1,2]. Quite understandably therefore, many of the earlier ideas about continental growth in this span of Earth's evolution were speculative. Finds of such relict minerals or other geologic remnants indicating existence of early crusts were rare, or, even if found, conclusions derived from some of them were found to be rather unreliable owing to imprints of later geologic events they carried which were masking the pristine history. It is obvious from such a scenario that most of the crust that formed between 4.5 and 3.9 billion years ago, must have perished soon; whether they were engulfed or resorbed by the mantle, or whether they piled up into thicker and denser masses only to sink soon back into the mantle in an unceasing cyclic process of creation and destruction, is difficult to say now[3–5].

The earliest well-preserved continental crusts, just a little less than 4.0 b.y., are the Acasta gneisses in Canada and slightly younger rocks in western Greenland, North America, Antarctica, China and western Australia[3,6]; in India, such ancient crusts dated between 3.5 and 3.8 b.y. or older have been reported from the Older Metamorphic Group (OMG rocks) in the Singbhum batholith in Bihar, and the Grey gneiss in Rajasthan; and from Karnataka and Orissa, younger examples are reported[7–9]. Today questions for which earth scientists are trying to seek answers are: how much continental crust formed early out of the mantle; whether the extent or spread of the continents continued to be the same ever since they fractionated early or did they grow gradually with fresh increments of crustal slices?[10].

Two contemporary models on this subject of crustal growth are current today, but they present diametrically opposite view points. One of them considers that the total volume of continental crust had increased steadily with progress of geologic time. This view draws support from (a) the global spread of continental crust and their eroded equivalents which are found to vary through different ages; (b) the observed changes in the chemical composition of mantle extract forming the upper crust which varies from sodium-rich crust of the Archaean times (tonalite–trondjemite–granodiorite or TTG) to potassium-rich crust of younger periods[5]. This model, however, is considered inadequate, by some, inasmuch as the early Archaean melt is not basaltic, as one would expect, but of TTG composition[5,11,12]. According to the second model, the volumes and bulk composition of continental crust had essentially remained the same (steady-state system) over most of Earth's history with new crustal growth balancing the recycled eroded materials of earlier formed crust which were dragged back into the mantle[13,14]. This impasse about the early continental growth is presently beginning to clarify thanks to advances in geochemistry during the past few decades, in particular, to the developments in nuclear and isotopic geochemistry. With increasing availability of newer and improved analytical techniques to precisely evaluate these fresh geochemical models, Earth's initial half-billion year history may finally unfold and scientists may soon be able to rewrite its early enigmatic chapters.

A. W. Hoffmann of the Max Planck-Institut für Chemie in Mainz, Germany, suggests that calculations of 'residence age', which is the 'average length of time the source rocks of the sediments have resided in the continental crust (as opposed to Earth's mantle)', may be a good index for understanding this phase of crustal evolution[10]. The 'residence age' is obtained using an isotopic method based on the behaviour of the rare earths samarium and neodymium in the mantle. During differentiation of mantle, neodymium prefers to enter into the crustal fraction depleting itself in the mantle reservoir[3]. With passage of time, this leads to a relative enhancement of samarium and the Sm/Nd ratio in the mantle. Also, the radioactive decay of the samarium isotope (^{147}Sm) yields a daughter product ^{143}Nd (half-life 106×10^9 years) and the ratio of radiogenic to non-radiogenic neodymium (^{143}Nd/^{144}Nd) in the mantle becomes higher progressively, while in the crustal sediments, it gets lower. As against residence ages of 1.5 billion years for the present day sediments, those deposited more than 3 billion years ago show ages not much greater than their deposition age. According to Hofmann, this implies that 'at the time, all of the continental material in existence was quite young and that much older continents simply did not exist', or alternatively, early crust 'has been in a steady state' and whatever slice formed had a short life cycle as their creation and subsequent destruction were rapid.

Some geochemists have used directly the ^{143}Nd/^{144}Nd ratios observed in a few mantle-derived volcanic rocks to interpret the degree to which crustal fractionation of the mantle has been accomplished. This ratio is higher in a differentiated and lower in an undifferentiated mantle. Surprisingly, several of the Archaean volcanic rocks examined by them indeed showed higher ratios, suggesting that the mantle reservoir had already differentiated sufficiently, when these rocks erupted. The logical inference about such a state of the mantle is that the continental crust must have formed in bulk quite early. But, Hofmann[10] feels that all these isotopic studies leave certain aspects unanswered. The calculation of residence ages, for example, does not precisely answer 'whether the mass of the continental crust has irreversibly grown or whether it has maintained an approximately constant mass in a steady-state process of creation and destruction'. Similarly, inferences from direct ^{143}Nd/^{144}Nd ratios in mantle-derived volcanic rocks about the state of the mantle reservoir can also be faulted on the grounds, that 'the same increase in ^{143}Nd/^{144}Nd ratios can be produced by high Sm/Nd ratio over a short time span or by a much lower Sm/Nd ratio over a much longer time'; also the much needed initial ratio values for this isotopic pair has to be derived by back calculations from present day figures, which, according to Hofmann, is rather an illogical approach.

Recently, a trace element method based on the elements niobium and uranium has been advanced by Paul J. Sylvester and colleagues at the Australian National University in Canberra, which claims greater reliability in tracing the growth of continental crust in Earth's early history[15]. Niobium and uranium are known to be incompatible elements in the mantle fractionating to crust and, among the two, uranium is fractionated more. Over geological time spans, when increasing volumes of crustal segments separate from the mantle, considerable depletion of uranium from the mantle is expected. As against Nb/U ratio of ~10 for the continental crust, the values for the primitive mantle is ~30 (based on chondritic meteorites which represent materials from which Earth was formed[16,17]), and for the present day mantle, this ratio is 47 (as observed in the mid-oceanic ridge basalts and ocean-island hot spot basalts which are mantle derived). Sylvester and colleagues, who measured Nb/U ratio in several samples of Australian basalts which had erupted direct from the mantle 2.7 b.y. ago, found it to be near 47, which is the ratio in the present day mantle. They argue that this is a clear proof that by 2.7 b.y., most of the uranium in the mantle has been lost to the continents, implying thereby, a rapid growth of continents early in the Earth's history. Vast areas of crust formed in the first half-billion year period were rapidly recycled back into the mantle aided by the slow cooling of the mantle due to unabated heating from higher amounts of radioactivity present during those early times. Such a state of the mantle also helped to keep the plate tectonic activity very efficient and subductions of the crust effective (more than 100 separate plates are visualized during the period 2.5–4.5 b.y.). According to Sylvester and his colleagues, fresh crust continuously being generated from the mantle had maintained balance of the total volume of continental rock constant, at least for 2.7 b.y.

Geochemists feel that though Sylvester's views about rapid continental growth is a breakthrough, their conclusions based on the Australian basalts, which represent only a small part of the global mantle reservoir, require support from data on similar basalts from other parts of the world also. Secondly, the Australian basalts are relatively young and erupted around 2.7 b.y. ago, by which time considerable volume of continents must have grown[5,10]. Similar conclusions had earlier been advanced on >3.8 b.y. old rocks of Singbhum batholith in eastern India where the authors[7] felt that the mantle in this region must have already differentiated sufficiently. These, no doubt, add strength to the view of a rapid crustal formation early in Earth's history.

Notwithstanding the dearth of reliable geologic records, geochemists are now better geared to be able to probe into the birth and growth of Earth's first 500 million years, hitherto a *terra incognita* and pull it of the domain of speculation.

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MEETINGS/SYMPOSIA/SEMINARS

National Seminar on Modern Trends in Environmental Analytical Chemistry

Date: 3–5 November 1997
Place: Raipur

Topics include: Toxic trace metals and inorganic pollutants; Organic pollutants including pesticides and polymers; Modern monitoring techniques, i.e. AAS, ICP-AES, GC-MS, X-ray fluoroscence, etc.; Low-cost instruments for monitoring of pollutants; Industry–University research interactions in teaching and research on pollution.

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National Symposium on the Recent Trends in Fullerene Research

Date: 1–2 December 1997
Place: Kanpur

Topics include: Synthesis; Methodology and techniques; Isolation and separation; Characterization; Physico-chemical and structural features of fullerene and its derivatives; Structure–property relationship and possible applications; Productionization of fullerene – various constraints; Molecular bonding and electronic structure of fullerenes; Fullerenes as precursor for nanophase materials, diamond-like carbon and other forms of carbon.

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National Seminar on Tectonomagmatism, chemistry and Metamorphism of Precambrian Ter and Group Discussion on Granulites, Enderbite Granulite Facies Rocks

Date: 16–19 December 1997
Place: Udaipur

Scientific sessions broadly include: Precambrian greenstone gneiss-granulite terrains and sedimentary belts; Metamorphis anatexis; Precambrian magmatism and metallogeny; Geoph modelling for crust–lithosphere evolution.

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