NEWSLETTER GEOBRASIL
(www.geobrasil.net)

- **NATURE**

Palaeontology: Leg feathers in an Early Cretaceous bird 925
FUCHENG ZHANG AND ZHONGHE ZHOU
This feature supports the idea that the evolution of flight involved a four-winged stage.
doi:10.1038/431925a

Genome duplication in the teleost fish Tetraodon nigroviridis reveals the early vertebrate proto-karyotype 946
OLIVIER JAILLON et al.
doi:10.1038/nature03025

Extreme climate of the global troposphere and stratosphere in 1940–42 related to El Niño 971
S. BRÖNNIMANN, J. LUTERBACHER, J. STAEHELIN, T. M. SVENDBY, G. HANSEN & T. SVENØE
doi:10.1038/nature02982

Release of gold-bearing fluids in convergent margin magmas prompted by magnetite crystallization 975
WEIDONG SUN, RICHARD J. ARCULUS, VADIM S. KAMENETSKY & RAYMOND A. BINNS
doi:10.1038/nature02972
A Silurian sea spider 978
DEREK J. SIVETER, MARK D. SUTTON, DEREK E. G. BRIGGS & DAVID J. SIVETER
doi:10.1038/nature02928

- **SCIENCE**

Age, Origin and Cooling History of the Coronel Joao Sa Pluton, Bahia, Brazil LEON E. LONG, CHRISTINA H. CASTELLANA, and ALCIDES N. SIAL J. Petrology published 22 October 2004, 10.1093/petrology/egh070 http://petrology.oupjournals.org/cgi/content/abstract/egh070v1?ct

The effect of substrate on the efficacy of seismic courtship signal transmission in the jumping spider Habronattus dossenus (Araneae: Salticidae) Damian O. Elias, Andrew C. Mason, and Ronald R. Hoy J. Exp. Biol. 2004; 207(23): p. 4105-4110 http://jeb.biologists.org/cgi/content/abstract/207/23/4105?ct

Ringwoodite lamellae in olivine: Clues to olivine-ringwoodite phase transition mechanisms in shocked meteorites and subducting slabs Ming Chen, Ahmed El Goresy, and Philippe Gillet Proc. Natl. Acad. Sci. USA. 2004; 101(42): p. 15033-15037 http://www.pnas.org/cgi/content/abstract/101/42/15033?ct

Dimensional reduction for a Bayesian filter Alexandre J. Chorin and Paul Krause Proc. Natl. Acad. Sci. USA. 2004; 101(42): p. 15013-15017 http://www.pnas.org/cgi/content/abstract/101/42/15013?ct

Regional crustal thickness and precipitation in young mountain chains W. G. Ernst Proc. Natl. Acad. Sci. USA. 2004; 101(42): p. 14998-15001 http://www.pnas.org/cgi/content/abstract/101/42/14998?ct

The timing of eukaryotic evolution: Does a relaxed molecular clock reconcile proteins and fossils? Emmanuel J. P. Douzery, Elizabeth A. Snell, Eric Bapteste, Frederic Delsuc, and Herve Philippe Proc. Natl. Acad. Sci. USA published 19 October 2004, 10.1073/pnas.0403984101 http://www.pnas.org/cgi/content/abstract/0403984101v1?ct

- **IAPC**

Geology of Ore Deposits

Vol. 46, No. 5, 2004
Simultaneous English language translation of the journal is available from MAIK "Nauka / Interperiodica" (Russia).
Geology of Ore Deposits ISSN 1075-7015.

Cavitation Mechanism of Formation of Nano-
and Microsize Particles of Minerals in Ore Deposits

V. V. Adushkin, S. N. Andreev, and S. I. Popel p. 313 abstract

Endogenous Regimes and Uranium Metallogeny of the Erzgebirge
and Central France Ore Districts

V. I. Velichkin, B. P. Vlasov, M. Cuney, and B. Poty p. 321 abstract

Minerals and Formation Conditions of Ores of the Teremkin Gold Deposit
(Eastern Transbaikal Region, Russia)

V. Yu. Prokof'ev, L. D. Zorina, I. A. Baksheev,
O. Yu. Plotinskaya, O. E. Kudryavtseva, and Yu. M. Ishkov p. 332 abstract

The Kamennoe Gold Sulfide Deposit (Northern Transbaikalia, Russia)
as a Representative of the Riphean Epithermal Gold–Telluride–Silver Ore Mineralization

A. G. Mironov, S. M. Zhmodik, A. A. Borovikov,
B. B. Damdinov, B. B. Guntypov, and N. V. Verkhovtseva p. 353 abstract

Chemical Composition of Carbonatite Minerals in Karasug Deposit, Tuva

A. V. Bolonin and A. V. Nikiforov p. 372 abstract

Garnet-Bearing Zones of Postmagmatic Rhyolite Alteration
at the Dukat Ore Field and Their Relation to the High-Grade Gold–Silver Ores

L. G. Filimonova p. 387 abstract

Tungsten Mineralization in Areas of Basite–Ultrabasite Magmatism

V. N. Voyevodin p. 397 abstract

Geochemistry International

Vol. 42, No. 10, 2004
Simultaneous English language translation of the journal is available from MAIK "Nauka / Interperiodica" (Russia).
Geochemistry International ISSN 0016-7029.

Behavior of the Sm–Nd, Rb–Sr, K–Ar, and U–Pb Isotopic Systems during Alkaline Metasomatism: Fenites in the Outer-Contact Zone of an Ultramafic–Alkaline Intrusion

V. M. Savatenkov, I. M. Morozova, and L. K. Levsky p. 899 abstract

Crystallization Kinetics of Andalusite and Sillimanite during the Kyanite -> Andalusite, Kyanite -> Sillimanite, and Andalusite -> Sillimanite Transitions

- **EARTH PAGES**

Anthropology and geoarchaeology

The earliest granny factor

One of the unique features of humanity is the progress of women into infertility after the onset of the menopause. Females of all other animal species, including primates, remain potentially fertile until they die, even when kept alive in zoos well beyond their natural life spans. When the menopause arose is difficult, if not impossible to judge, but the advantage of surviving grandparents, especially grannies released from the burden of child-bearing and care, is huge. They carry knowledge from two generations or more before the lives of their descendants, and they have the time to confer it on children. Once grandparents became common members of families, effectively they would have doubled the potential for teaching and learning. That has immense importance for human survival and development. In 1990 I witnessed this in action in a remote and war-torn part of Eritrea. There was a drought worse than any since 1918, and villagers were frantically searching for drinking water for themselves and their livestock, to the extent that they were felling giant baobab trees, more than 300 years old, to get to their water-rich inner core. While we were attempting, with little success, to advise a group on where to dig a new well a young boy with a large camel arrived. On it was a couple well into their 80s. They directed attention to a particular spot, digging resumed, and after 2 hours water was struck. That place was where the couple remembered a well being dug in the great drought of 1918. It is possible to get some idea of when the possible influence of grandparents arose by finding evidence about age distribution in ancient populations. The further back in time, the more incomplete are human remains. However, teeth have the highest of all survival chances, and the do carry evidence of the age of the person who chewed with them, from the wear patterns and the presence or absence of late-erupting teeth (Caspari, R. & Lee, S.-H. 2004. Older age becomes common late in human evolution. *Proceedings of the National Academy of Science, USA*, v. **101**, p. 10895-10900). Caspari and Lee's work used more than 750 samples of human teeth, dating back to some of the earliest hominids. The measure that they adopted to assess onset of old age does not increase gradually into more recent times, but undergoes a remarkable jump around 30ka. Interestingly, this coincides with the explosion of art of the highest quality in Europe. Was it the oldsters who made that leap or was it their influence that opened up new horizons for their grandchildren. Other than this remarkable possibility, the opening of culture as we know it is hard to explain.

Black Sea flooding put to test

In the mid-1990s, William Ryan and Walter Pitman of the US Lamont-Doherty Earth Observatory captured a much wider audience than is the normally the case for geoscientists, when they announced evidence from the Black Sea that seemed to confirm legends of the Flood in the Old Testament and the Epic of Gilgamesh. They claimed that in early Holocene times, the Black Sea was a freshwater lake some 150 m below present sea level. At the time, global sea level was below the threshold of the floor of the Bosporus, thereby isolating the Black Sea from the world's oceans. Yet sea level was rising inexorably as continental ice sheets melted back. Around 8000 years ago, sea water flooded through the Bosporus to fill the Black Sea to its present level. Evidence takes the form of submerged beaches and even possible townships (mounds similar to the tells in Turkey and Mesopotamia formed during long-term occupation by Neolithic to Bronze Age cultures). Other features on the floor of the Black Sea are zones of large sand waves and signs of incision, ascribed by Ryan and Pitman to massive currents when flow began through the Bosporus. The way in which such flooding might have take progressed is testable using hydraulic modelling, although the topographic parameters are complex (Siddall, M. *et* al. 2004. Testing the physical oceanographic implications of the suggested sudden Black Sea infill 8400 years ago. *Paleoceanography*, v. **19,** PA1024, doi:10.1029/2003PA000903). The work of Siddall and colleagues suggests a flow rate of 60 thousand m^3 s^{-1}, about that of a river as powerful as the Brahmaputra (see *Catastrophic erosion in Tibet*, this issue of *EPN*). That would have taken around 30 years to fill the Black Sea to its present level; far longer than the Biblical 40 days and nights, but quick enough to force large-scale migration and to live on in legend. The model fits with the seabed sand waves and channelling, and being based only on known topography and post-glacial sea level rise, rather than the myths, it carries weight scientifically. However, little is known about the way in which young sediments in the Black Sea basin formed, and proper documentation awaits their coring..

See also: Schiermeier, Q. 2004. Noah's flood. *Nature*, v. **430**, p. 718-719.

Climate change and palaeoclimatology

How often did it rain?

Geoscientists have become used to masses of climate data, often with better than 50 years resolution, from cores through ice sheets and sea-floor sediments. But all of it is from some kind of proxy; oxygen isotopes for air temperature and land-ice volume, methane for humidity, dust for windiness, and so forth. One aspect of both climate and the British obsession with weather is raininess, for which there is scant evidence. How many rainy days occur in a British summer is interesting, but for studies of past climate evidence for the onset or disappearance of seasonality, and the annual intensity and duration of rainfall would be invaluable, if it could be had. A piece of ingenious research shows that it is possible (Kano, A. *et al*. 2004. High-resolution records of rainfall events from clay bands in tufa. *Geology*, v. **32**, p. 793-796). Akihiro Kano and Japanese colleagues studied the well-known layering of tufa – carbonate veneers laid down in freshwater that has high dissolved bicarbonate and calcium ions. In "hard-water" areas tufa can be deposited very quickly, at rates above a few millimetres per year, and it tends to be preserved, being quite tough. So tufas have the potential for preserving annual records of various fluctuations. Kano and colleagues saw that colour laminations represented clays deposited in the tufa when the water was turbid after prolonged rainfall. To record the variations they simply measured fluorescent X-rays emitted by silicon when slices of tufa were examined in an electron microprobe – silicon is present in clays and silt, but not in carbonate minerals. Because they used tufa deposited in recent times (1988-2002) they were able to correlate variations in clay content with detailed weather records from the site, thereby calibrating their method. The match was very good and followed rainfall closely at the level of a few days. Of 112 high rainfall days in the abnormally wet year of 1993, 100 showed up in the clay record. So, tufas are potentially more revealing than even the annual growth rings in wood, and some tufa deposits preserve long records.

Details of the last interglacial climate

Worries about how anthropogenic warming will affect the course of the Holocene interglacial in which we live might be tempered or exacerbated by knowing what went on during the previous, Eemian interglacial that ended about 120 ka ago. Data from cores through the Greenland and Antarctic ice sheets have been both ambiguous and plagued by resolution that does not show enough detail, but a core from a new position in Greenland seems to resolve both problems (North Greenland Ice Core Project members 2004. High-resolution record of Northern Hemisphere climate extending into the last interglacial period. *Nature*, v. **431**, p. 147-151). Uniquely, the NGRIP ice still preserves the annual snow layering as far back as 123 ka. This is because the site shows little sign of the deformation at deep levels that characterised previous Greenland cores. That is probably because the site lies above a zone of high heat flow through the underlying crust, so that the base of the ice has melted. Melting helps prevent internal deformation, but that in itself is a surprise because the site was chosen because it is colder and drier at the surface than other sites. The drilling objective was to penetrate older ice than the Eemian to give a fuller record than from earlier cores, yet anticipated poor time resolution. The presence of resolvable annual records from depth was both a surprise and a bonus, although the melting had removed ice from the earliest part of the last interglacial. Despite that, preliminary oxygen-isotope results from the NGRIP core suggest that the Eemian had a remarkably stable climate and one that was warmer than that of the Holocene by about 5ºC; maybe it is an analogue for climate evolution during a future, artificially warmed world. That possibility stems from the observation that around 115 ka, North Atlantic climate suddenly warmed Thereafter, interglacial conditions did not suddenly change to glacial, as happened several times during the course of the last glacial epoch, but took around five millennia after the sudden warming. The authors make no claims that their preliminary data help resolve current fears of warming collapsing to glacial conditions in a matter of years to decades. That grim scenario has been widely trumpeted both by the media and some climate scientists. There is more to the Eemian than the period after 123 ka, and who knows what the eventual annual resolution will show up? The data presented in the paper are from a coarse sampling of 55 cm that represents about 40 year intervals.

See also: Kuffey, K.M. 2004. Into an ice age. *Nature*, v. **431**, p. 133-134

For and against "Snowball Earth"

Reputedly glaciogenic sediments in the Neoproterozoic are reckoned to represent at least three separate cold episodes, the Sturtian (~720 Ma), Marinoan (~600 Ma) and Varangerian (~580 Ma). Sadly, the diamictites that characterise these episodes are not easily dated. Only two have well-defined radiometric ages, the Gubrah Member in the Oman (713 Ma), said to be Sturtian, and the Gaskiers Formation of Newfoundland (580 Ma), a possible example of the Varangerian that is better exposed in northern Norway. The truly whopping Sturtian and Marinoan diamictites of Australia are fitted to a global stratigraphy on the basis of carbon isotope variations, as are those of Namibia on which Paul Hoffman and colleagues stake their claims to "Snowball Earth" events. Another Hoffman, native to Namibia, and geochemists at MIT, have finally given a believable age to one of the Namibian diamictites (Hoffman, K.-H. *et al* 2004. U-Pb zircon dates from the Neoproterozoic Ghaub Formation, Namibia: constraints on Marinoan glaciation. *Geology*, v. **32**, p. 817-820). Their zircons come from a thin volcanic ash within isolated

Neoproterozoic diamictites in central Namibia, and yield an age of 636±1 Ma. Correlating the studied diamictites with the Namibian sequences elsewhere in the country relies on the presence of a supposed cap carbonate rather than lateral continuity. The authors link them with the younger of the two Namibian diamictites, the Ghaub Formation, rather than the Chuos Formation that lies at depth, despite the fact that both well-studied units are sometimes overlain by carbonate sediments. The conclusion is that the Ghaub is Marinoan, previously thought to be somewhere between 600 and 660 Ma. Interestingly, the new occurrence of diamictites is divided vertically by two thick sequences of volcanic lavas, neither of which have been dated by the authors.

One of the leading experts on what actually constitutes incontrovertible evidence for glacial sedimentation is Nicholas Eyles of the University of Toronto. He has become increasingly disenchanted with notions of Snowball conditions, on the basis of ambiguity in the very evidence said to signify them; diamictites with drop stones. He and Nicole Januszczac have assembled a monumental paper that counsels caution, and perhaps more (Eyles, N. & Januszczac, N. 2004. “Zipper-rift”: a tectonic model for Neoproterozoic glaciations during breakup of Rodinia after 750 Ma. *Earth-Science Reviews*, v. **65**, p. 1-73). Part of their argument rests on the very lack of robust ages for Neoproterozoic diamictites that prevents believable correlations from continent to continent. It is the globally synchronous nature assumed for these glaciations that gave rise to the “Snowball Earth” notion. The palaeomagnetic latitudes are often used to support this, but they are error prone both palaeogeographically and geochronologically. Accepting evidence for glaciation at low latitudes is no guarantee of support for even cold extremes, let alone an icebound world. Solar heating in the Neoproterozoic was lower than now, and so, therefore, would be the elevations at which glaciers might form at different latitudes. But the main problem is reconciling the features of many supposed glaciogenic diamictites with modern ideas of what truly constitutes evidence for glacial transport and deposition. Few of the units on which the “Snowball Earth” hypothesis is based stand up to modern scrutiny. Most of the diamictite packages occur in tectonically controlled basins, that were subject to episodic rifting. Each can be considered to form the base of a “tectonostratigraphic” cycle, and many show abundant evidence of having formed as mass flows from a shelf into the basin. They include olistostromes with huge rafts of carbonates likely to represent failure of carbonate platforms and huge submarine landslides, similar to those being discovered off many large islands today. The 750 to 580 Ma period was one of the most dramatic episodes of continental break-up in Earth’s history as the Rodinia supercontinent was disassembled. Continental uplift, resulting either from mantle plume activity or rebound of rift shoulders, could have resulted in large areas rising above the ice limit, even at low latitudes in those cooler times. Those diamictites that are undoubtedly glaciogenic could easily have formed haphazardly in time. The carbon isotope record of immense shifts in $\delta^{13}C$ during the Neoproterozoic, linked by some to repeated collapses and resurrections of life, might just as easily have occurred through efficient organic burial in active extensional basins and repeated major volcanism from plumes. Only evidence of timing will tell, and three good dates for “Snowball Earth” events are simply not enough.

Geobiology, palaeontology, and evolution

Tighter link of end-Permian extinction with Siberian Traps

The volcanism versus impact debate about the K-T boundary runs and runs, as newshounds tend to say. Things are not so evenly balanced for the biggest of all mass extinctions at the end of the Permian. Although signs have been reported, a link with an impacting extraterrestrial body has not convinced a decisive majority. On the other hand, there is a 1-2 Ma mismatch between the well-determined age (around 253 Ma) of the Siberian Traps and previous dates for the end of Permian stratigraphy in sections that have no depositional break with the Triassic. The extinction has all the hallmarks of a catastrophe, by definition a sudden event, so tying down its age and that of a plausible cause is essential. Not being able to do that for the K-T event and the Deccan Traps, and with uncertainties about the relationship of impact rocks to signs of extinction at the Chicxulub site, add fuel to that long-running debate. The accepted “golden spike” or GSSP for the Permian-Triassic boundary is at Meishan in eastern China, and there are other sites in China that run it close. The sections contain several volcanic ash layers, so zeroing in on a date for the extinction would seem straightforward, using U/Pb zircon dating. There is a problem. Some of the zircons in the ashes are xenocrysts rather than having formed during the various magmatic episodes, and they are microscopically indistinguishable from those that should give precise dates. All the zircons also show signs of having lost radiogenic lead during later alteration of the beds. The last could explain the mismatch with the Ar-Ar age of the Siberian Traps, the generally favoured culprits for the extinction. US and Australian geochemists have taken a new tack in dealing with these problems (Mundil, R *et al*. 2004. Age and timing of the Permian mass extinction: U/Pb dating of closed system zircons. *Science*, v. **305**, p. 1760-1763). They have "aggressively" treated zircon grains to remove outer parts from which radiogenic lead has been lost, so leaving isotopically undisturbed cores of the grains. Their U/Pb data are mainly from a boundary section in central China (Shangsi), dating 8 separate ash layers, plus one from the boundary clay itself at the Meishan GSSP. The dates agree well with the stratigraphic sequence of the ashes, and hare high precision. Judging the actual age of the boundary at Shangsi relies on statistical analysis of the sequence of ages from the different ashes, and gives a date of 252.6±0.2 Ma. That is within error of the accepted Ar-Ar age of the Siberian Traps. As usual, this is not cut and dried, because there are other ages for the Siberian Traps, including one using the same U/Pb zircon method that suggests a 251.4 Ma age. Clearly the mismatches for the end-Permian events will be a meaty bone of contention, when all respected geochronologists turn up for a meeting early in 2005 to thrash out the conflicts that continually inflame their passions.

Geochemistry, mineralogy, petrology and volcanology

Sulphides in the ocean

About 2.3 billion years ago, ancient soils begin to reveal that Earth, or more precisely life upon it had developed an atmosphere that contained oxygen, albeit at quite low levels. One of the most interesting events during the Proterozoic Aeon was the world-wide disappearance of vast deposits of iron oxides known as banded iron formations or BIFs, at about 1.8 billion years. Many authorities view that as the time when sufficient oxygen was dissolved in seawater to have removed soluble Fe-2 at its source, on the ocean floor near hydrothermal vents – BIFs formed in shallow water, and that requires Fe-2 to have permeated the entire oceans. There is another possibility. The presence of atmospheric oxygen would have ensured the oxidation of iron sulphide exposed at the land surface, thereby adding sulphate ions to river water, and eventually seawater. Another line of evidence for atmospheric oxygen is the disappearance of detrital sulphide grains from sedimentary rocks younger than 2.3 billion years, so a build-up of sulphate ions in later seawater is quite plausible. Should deep-ocean chemistry have been reducing, it is possible that sulphide ions would form there. The insolubility of iron sulphides would then remove Fe-2 from seawater equally as efficiently as would oxygen. Danish and Canadian geochemists have investigated this possibility using data from sediments in Canada that mark the last phase of major BIF deposition around 1.8 billion years (Poulton, S.W. *et al*. 2004. The transition to a sulphidic ocean ~1.84 billion years ago. *Nature*, v. **431**, p. 173-177). They found that conditions changed from one in which seawater contained dissolved Fe-2 at the time of the last BIF deposition to one dominated by sulphide ions, similar to that found in modern anoxic waters such as those in the Black Sea. That would have sequestered any available Fe-2 to pyrite in sediments, a feature typical of many later Proterozoic sediments. Since seawater during the Phanerozoic was dominated by sulphate ions, except in periods of ocean anoxia, it looks likely that late Precambrian sulphidic oceans gave way to more modern sulphur chemistry following a rapid rise in atmospheric oxygen at the end of the Proterozoic. One consequence of highly-reducing deep ocean water would have been very efficient burial of dead organic matter while it lasted, because anaerobic bacteria do not fully convert organic molecules back to water and carbon dioxide. During the Neoproterozoic $d^{13}C$ in seawater underwent rapid swings from highly negative to highly positive, on which all kinds of connotations have been placed. Another explanation for the carbon hiccups might be that periodically there were short-lived increases in oxygenation of deep ocean water.

Geomorphology

Catastrophic erosion in Tibet

The world's most awesome natural spectacle is probably the Brahmaputra River in full spate. Unlike most large rivers, it is constrained for most of its course within a deep, narrow gorge that has to take the snow melt from a huge catchment on the northern flank of the High Himalaya, brought partly by the Tibetan Tsangpo River. Each spate hurtles onto the plains of Bangladesh, loaded with debris, at a rate of around 70 thousand cubic metres per second. Although that is but a third of the flood discharge of the Amazon, for much of the Brahmaputra's course it must pass through a gorge only a few hundred metres wide in places. This gives not inconsiderable erosive power, indeed probably the highest anywhere. Not surprisingly, little is known about the Tsangpo-Brahmaputra valley, because of its inhospitable character. With the recent release of ~90m resolution elevation data from the Shuttle Radar Topography Mission, it is now possible to analyse the whole catchment's morphology in detail, without needing to follow the individual rivers. Parts of the lower Tsangpo have remarkably high gradients, including a 100 km stretch with a fall of more than 2 km, through a gorge with almost 7 km of relief on either flank that cuts N-S across the axis of the Eastern Syntaxis of the High Himalaya. The gorge lies downstream of a west to east stretch with lower gradients, falling around 1 km in 300 km, which suggests some dramatic incision begins at the junction of the two sections. US and Chinese geomorphologists visited the area and discovered that high on the flanks of the upper Tsangpo are terraces of lacustrine sediments, at about 3100 and 3500 m (200 and 600 m higher than the river) (Montgomery, D.R. *et al*. 2004. Evidence for Holocene megafloods down the Tsangpo River gorge, southeastern Tibet. *Quaternary Research*, 9 September 2004 issue). Charcoal in the sediments gives radiocarbon ages between 1200 to 1600 BP and 8800 to 9800 BP for the lower and higher terrace levels, so the lakes formed during the Holocene. The terraces stop at a zone of thick glacial moraine, cut by the Tsangpo, which suggests that both formed in lakes behind two ice dams. Using SRTM data allows the volume of water ponded in both ice-dammed lakes to be estimated. The older and higher level indicates about 830 km^3, and the lower some 80 km^3. Breaching of the dams would have caused the largest recorded erosive events in recent Earth history, and explains the gorge below. Each flood discharge would have been between 1 and 5 million cubic metres per second, equivalent 3 to 15 times the maximum flood discharge of the Amazon.

Planetary, extraterrestrial geology, and meteoritics

Mars issue of Science

So, you are a geoscientist and you are interested in Mars. Excellent! Now read pages 793 to 845 of the 6 August 2004 issue of *Science* v. **305**. There is much to learn from 11 papers about the less revealing of the two Mars Exploration Rovers, Spirit. Rover Opportunity has been getting the headlines, with its discoveries that relate to the influence of surface and subsurface water on superficial Martian minerals, such as the now well-publicised "blueberries" made of hematite, and the presence of sulphates. A more informative digest of the mineralogy of Mars appears in the same issues' News Focus (Kerr, R.A. 2004, Rainbow of Martian minerals paints picture of degradation. *Science*, v. **305**, p. 770-771). Kerr makes clear that the really revolutionising instrument is orbiting Mars; the Visible and Infrared Mineralogical Mapping Spectrometer or OMEGA. That is part of the payload of the ESA Mars Express, and measures radiant energy from the Martian surface with such spectral and spatial resolution, that the results can be compared with standard spectra of terrestrial minerals to see what the Martian surface is made of. Hopefully, OMEGA will produce a hyperspectral database for the entire planet. The on-surface readings from the various instruments on the NASA Rovers play much the same role as a field geologist would, by providing "ground truth" to validate the broader scope of the OMEGA instrument. The hematite that dominates the overall red colour of Mars, has been confirmed by the Rovers, but to nobody's great surprise. The exciting find is just how much is owed to sulphate minerals, such as orange iron potassium sulphate, or jarosite. The sulphate-rich veneer could well point to the influence of sulphuric acid, let alone water in Mars' early surface environment, probably emitted as sulphur dioxide during intense volcanic activity. Interestingly, the incompatibility of highly acid surface water with the preservation of carbonates could have thwarted drawdown of CO_2 from the Martian atmosphere (Fairén, A.G. *et al*. 2004. Inhibition of carbonate synthesis in acidic oceasn on early Mars. *Nature*, v. **431**, p. 423-426). Formation and preservation of soil carbonate minerals would have collapsed the "greenhouse" warming mechanism demanded by the now proven influence of flowing water early in Martian history. So long as sulphurous volcanic emissions overwhelmed carbonate formation, Mars might have stayed wet and warm. The key is the duration of massive volcanism, which could be tied down by seeing how lavas have been affected by impacts in the minute detail possible from another Mars Express imaging instrument, the High Resolution Stereo Camera. Planetary volcanic specialists reckon massive volcanism lasted for a considerable time

Tectonics

Mantle dripping off mountain roots

Continental arcs, such as the Andes, parts of the Himalaya and Tibetan Plateau and the Sierra Nevada of the western USA, are stuffed with granite intrusions. Large volumes coalesce to form classic batholiths. It is now well-accepted that very little of the granitic magma originated by melting of older continental crust, but by processes of fractionation from more mafic parent magmas. That presupposes a layer of dense, mafic to ultramafic cumulates below and complementing up to 30 km of batholithic crust. The overall density of the continental arc crust would be high relative to that of the granites themselves. So the fact that many batholithic cordilleras are topographically high suggests one of several processes: either the granitic part of the crust has become tectonically thickened relative to its denser root, or that root has separated from the continental lithosphere as a whole, and sunk into the mantle. Such decoupling, or delamination, would induce the remaining lithosphere to rise dramatically. Also, its descent could result in partial melting to produce peculiar potassium-rich basaltic magmas. The latter occur in Tibet and their presence there has been linked to foundering of deep lithosphere, that may have triggered the relatively recent surge in Himalayan uplift. Proving the existence of a descending lump of lithosphere is not easy, but developments in seismic processing can make a crucial contribution, if sufficient data are available for a suspected zone of delamination. The western USA is blessed with lots of seismic stations, so is a natural place to try out the new techniques as a test of the hypothesis. George Zandt of the University of Arizona, and other US colleagues have come up with interesting results (Zandt, G. *et al*. 2004. Active foundering of a continental arc root beneath the southern Sierra Nevada in California. *Nature*, v. **431**, p. 41-46). Their analyses of seismic data shed light on a late stage in the development of the Sierra Nevada. During the Mesozoic Era, subduction beneath North America of the now disappeared Farallon plate of Pacific ocean lithosphere built up the Sierra Nevada batholith. About 10-16 Ma ago, subduction stopped and the plate margin became one of transpression, the most prominent feature of which is the San Andreas Fault. At that stage, a "drip" of dense cumulates began to form, and subsequently separated to descend into the mantle. Cruustal rebound was not simple but included zones of extension, as well as tell-tale high-K volcanism during the Pliocene.

The people interested in receiving our newsletter through mail, can write to acfonseca@geobrasil.net or revistadegeologia@yahoo.com.br

******Le persone interessate in ricevere la nostra newsletter tramite e-mail, posso scrivere ad acfonseca@geobrasil.net ou revistadegeologia@yahoo.com.br..***