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WORKSHOP-SUSTENTABILIDADE HÍDRICA DO SEMI-ÁRIDO NAS ÁREAS-PILOTO: GUARIBAS-PI, LAGOA REAL-BA E ARARIPINA-PE

29 de setembro de 2003, Museu Geologico, Salvador, Bahia
Informacoes pelo mail: fnasciment@cetem.gov.br ou rafael@cbpm.com.br

♦ ÍNDICE DE NOTÍCIAS

- **AMBIENTE BRASIL**

DESCOBERTAS DE ÓLEO E GÁS NO BRASIL SUPERAM EXPECTATIVAS

Os dados divulgados pela Petrobras indicam que a companhia descobriu, no Brasil, nos últimos doze meses, cerca de 4 bilhões de barris de óleo - 1 bilhão de excelente qualidade - e 419 bilhões de metros cúbicos de gás natural.

EMBRAPA DESENVOLVE TÉCNICA PARA DIMINUIR A EROSÃO E A POLUIÇÃO AMBIENTAL

A Embrapa Trigo (Passo Fundo/RS) desenvolveu uma técnica para controle de enxurrada no Sistema de Plantio Direto, chamada Mulching Vertical, que diminui os riscos de erosão e ainda reduz o transporte de fertilizantes e de defensivos agrícolas para mananciais de superfície.

- **JORNAL DA CIÊNCIA**

CT-PETRO INVESTE R$ 47 MILHÕES ATÉ 2004

O Fundo Setorial de Petróleo e Gás - CT Petro - anunciou em Brasília investimentos da ordem de R$ 47 milhões para implementação de projetos este ano e continuidade em 2004

O apoio às empresas da cadeia produtiva do setor de petróleo e gás natural, em parcerias entre Universidade e empresa será um das linhas de financiamento, com recursos de R$ 7 milhões.

São projetos cooperativos entre empresas do setor e Universidades, institutos e centros de pesquisa, com contrapartida financeira obrigatória das empresas.

Outra grande linha de atuação definida foi o apoio à pesquisa básica em áreas com potencial de aplicação no setor de petróleo e gás natural. Serão R$ 21 milhões destinados até 2005.

O comitê definiu ainda o apoio às redes cooperativas de pesquisa, inovação e transferência de tecnologia do setor de petróleo e gás natural das regiões norte e nordeste, com R$ 6 milhões de reais.

O objetivo é consolidar as redes atuantes nessas regiões, permitindo a inclusão de novos projetos, complementação de infra-estrutura e concessão de bolsas de desenvolvimento tecnológico.

Ficou definido também o investimento de R$ 2 milhões para novas empresas de base tecnológica por meio de incubadoras de empresas. A Rede Brasil de Tecnologia foi contemplada com R$ 4 milhões.

Criada por decreto presidencial, a rede tem objetivo de promover a capacitação de empresas na substituição de importação, com a interação entre Universidades, empresas e administração pública para desenvolvimento de setores produtivos locais.

Criado em 1997 o CT -Petro já investiu nestes cinco anos mais de R$ 364 milhões de reais, dos quais R$ 80 milhões, equivalente a 22%, foram aplicados em capacitação de recursos humanos, sendo que 40% desses valores foram destinados à região Norte e Nordeste.

Presidido pelo secretário de Política de Informática e Tecnologia do MCT, Francelino Grando, o comitê gestor do fundo é composto ainda por representantes do Ministério das Minas e Energia, Agência Nacional de Petróleo (ANP), Finep, CNPq, dois representantes da comunidade científica: Unicamp e UFBA e dois do setor produtivo: Instituto Brasileiro de Petróleo e Gás (IBP) e Associação Brasileira da Infra-Etrutura e da Indústria de Base (ABDIB).

Além dessas ações, o comitê de coordenação do fundo pretende ainda este ano elaborar o plano de ação para o próximo triênio 2004/2007 e lançar outros editais para seleção e contração de projetos para 2004.

Assessoria de Comunicação do MCT

ROCHA SUBTERRÂNEA PODERÁ SER ESTOQUE DE LIXO TÓXICO E NUCLEAR

Camada consegue impedir contaminação de água
Marcus Vinicius Marinho escreve para a 'Folha de SP':

Poder enterrar lixo tóxico e nuclear e deixá-lo lá por milhões e milhões de anos, sem perigo de contaminação, sempre foi o sonho de ambientalistas, indústrias e governos.

Segundo cientistas franceses, isso pode ser possível no futuro com o auxílio de rochas conhecidas como aquitardes.

Os aquitardes são camadas de rocha subterrânea com baixíssima permeabilidade, ou seja, são tão sólidas que não deixam quase nada passar, mesmo que por longos períodos de tempo.

Cientistas do Centro de Pesquisas Petrográficas e Geoquímicas, na França, fizeram testes na bacia de Paris com uma dessas camadas, chamada de Trias e Lias (o nome da camada vem de ela ter sido formada no fim do período Triássico e no começo do Liássico, há cerca de 190 milhões de anos).

Descobriram que é sólida o suficiente para abrigar grandes quantidades de lixo tóxico sem oferecer risco de contaminação de águas subterrâneas.

'É difícil dizer que os aquitardes são a solução para o lixo tóxico só com um exemplo', disse por telefone Christian France-Lanord, um dos geólogos responsáveis pela pesquisa.

'Podemos dizer, no entanto, que a permeabilidade deles é baixa o suficiente para isolar rejeitos químicos ou nucleares por milhões de anos.'

Para avaliar se as rochas estudadas tinham o potencial de confinamento para ser bons reservatórios de lixo em escala geológica, France-Lanord e seus colaboradores resolveram medir as propriedades da água que envolve a camada de Trias e Lias.

Os cientistas verificaram que as águas que estão acima da rocha não entraram em contato com as águas que estão abaixo dela na última dezena de milhões de anos. Ou seja, a separação feita pelo aquitarde foi completa durante o período.

O problema principal da equipe era criar um método de simulação ou verificação do que poderia acontecer no aquífero nessa escala de tempo.

Algumas tentativas de fazer simulações em laboratório já haviam sido realizadas sem sucesso na Europa e no Japão. Modelos matemáticos também não tinham produzido frutos.

Para resolver o problema, os pesquisadores se utilizaram de uma espécie de detector geoquímico para tentar medir o que aconteceu nos últimos milhões de anos: o hélio-4.

Esse gás inerte é uma substância estável, que pode ser usada como indicador para diferenciar a origem das águas.

Como o decaimento radioativo de urânio e tório nas profundezas libera muito gás hélio-4, águas muito profundas costumam ter maior quantidade do gás dissolvido do que as águas mais próximas da superfície.

Medidas comparativas podem determinar se houve contato entre águas de profundidades diferentes.

'A utilização do hélio-4 para as medidas foi o grande diferencial de nossa pesquisa. Os dados das pesquisas anteriores eram contraditórios, mas a utilização desses detectores geoquímicos não deixa dúvidas', diz France-Lanord. 'Nosso método poderá ser repetido ao redor do mundo.'

As camadas acima e abaixo do aquitarde de Trias e Lias são aquíferos, ou seja, rochas porosas que permitem a passagem e a estocagem de água.

São, no caso, o aquífero Dogger -formado no período Jurássico, há cerca de 160 milhões de anos- e o aquífero Trias -originário do Triássico, há cerca de 215 milhões de anos.

Para obter amostras de água do aquífero Dogger, acima do aquitarde, e do aquífero Trias, abaixo da camada, os cientistas usaram água recolhida em 24 poços de regiões diferentes da França.

As profundidades variaram de 80 m a 834 m abaixo do nível do mar.

Segundo France-Lanord, uma limitação para usar o aquitarde como estoque de lixo seria a existência de falhas e fraturas na rocha. 'É preciso que se estude exaustivamente a região a ser utilizada, para que se minimize esse perigo', disse.

O estudo foi publicado no último número da revista científica britânica 'Nature' (http://www.nature.com).

Folha de SP, 10/9

- **COMCIÊNCIAS**

PRESERVAÇÃO AMBIENTAL

Especialistas alertam para o possível desaparecimento de espécies arbóreas do cerrado em 2055
- Pesquisadores do Cria simularam, com modelos computacionais, a distribuição de 162 espécies arbóreas do cerrado em 2055. O cenário obtido pelos biólogos é preocupante: a distribuição das espécies declina drasticamente de 25 até 90% da área original.
http://www.comciencia.br/noticias/2003/05set03/cerrado.htm

GESTÃO TERRITORIAL

Curso otimizará gerenciamento de áreas costeiras
- A ocupação do litoral brasileiro tem se dado de forma desorganizada e ameaçadora para o equilíbrio dos ecossistemas. Este fato tem preocupado pesquisadores da Univali, de Santa Catarina, que, através do Centro de Ciências Tecnológicas da Terra e do Mar, estão oferecendo o Curso de Especialização em Cidades Litorâneas com Ênfase em Gerenciamento Costeiro Integrado, que deverá otimizar a gestão de cidades litorâneas.
http://www.comciencia.br/noticias/2003/05set03/zona_costeira.htm

- **INFOMET**

Mineracao & Nao-Ferrosos
Vale do Rio Doce assume o controle integral da Caemi
Antofagasta se concentra em mineracao
Na ponta da venda
MBR e Samarco batem recorde de producao
Mitsui entra no capital da Vale e vende Caemi
Linha 2 da Alcasa alcanca 100% de pureza
Nibrasco comemora 25 anos de atividade
Dilma diz que mineracao tera´ apoio
Vale conclui compra da Caemi e prepara mudanca na gestao
Compra da Caemi e´ concluida
Teck Cominco desenvolve novo processo para obtencao de zinco metalico
IMA planeja perfuracoes em Navidad
Wheaton compra participacao em mina mexicana
Consumo domestico de aluminio caiu 12,6% no primeiro semestre
Pista limpa
Franca da´ aval para Alcan comprar empresa de aluminio no pais
Barcos de aluminio conquistam mercado
Votorantim amplia producao de aluminio
Cerro Crespo surpreende Southwestern
Anglo recebe sinal verde para adquirir acoes da Kumba Resources
Chile tem superavit gracas ao cobre

- **PORTAL DO GEÓLOGO**

Ouro. A volta dos investimentos
Como o Coltan afeta o Brasil
Arcelor acelera sua ambição brasileira e entra na siderúrgica maranhense
Anglo avança no ferro
Auto-suficiência! Estamos quase lá
Descoberta pode triplicar reserva de gás do país
A dura vida das Majors II
Pechiney rejeita nova oferta da Alcan
Brasil e a siderurgia
O vazamento de óleo na Califórnia e o meio-ambiente do Brasil
A transposição do S. Francisco- Furo N'água.
Australianos aumentam a produção de ouro
Volcan fecha com Glencore
A fusão Outokumpu x Boliden
Relatórios anuais em pauta
Turquoise Hill
Ouro. Em queda ou em alta
Use a criatividade. Dê uma gema semi-preciosa de presente
Rochas Ornamentais terão Linha de Crédito
O Brasil e o Alumínio
Australianos se preparam para o retorno da Anglo American
Norilsk aproveita a demanda e fatura
Pequeno minerador. Uma luz no fim do túnel.
O carvão e a onda de calor
Puma-Onça já é numero 1 no Brasil

- **MUNDOGEO**

Inpe promoverá encontro para usuários de imagens de satélites em Natal
Autodesk fornece solução para topografia
Absolut Technologies lança placa gráfica para aplicativos GIS
Mapa gigante do IBGE é atração no Palácio do Planalto
Reinaugurado o Museu de Topografia da UFRGS
Edinfor apresenta projetos de GIS no Enershow 2003 em São Paulo
Brasil deve manter acordo espacial com a Ucrânia
Centro de Informações e Dados mapeia o desmatamento no Rio de Janeiro
Lançada a quarta edição do livro "GPS - Uma Abordagem Prática"

- **NATURE**

EARTHQUAKE FIRED STEAM-POWERED BOULDERS

Heat from sliding rocks created pressure-cooker effect.
3 September 2003
PHILIP BALL

It was no ordinary earthquake that struck near the town of Chi-Chi in central Taiwan on 21 September 1999. The ground seemed to explode as huge boulders were flung into the air, and flashes of light lit the night sky.

Taiwanese geologists have now explained this unusual and terrifying geological event. The boulders were powered by high-pressure steam, they say, as sliding rocks heated ground water to boiling point[1].

The earthquake, which occurred in the middle of the night about 100 miles south-west of Taipei, was the largest in Taiwan for over a century, registering 7.6 on the Richter scale. It killed around 2,400 people, and caused US$30-50 billion worth of damage.

The Chi-Chi quake created a crack 100 kilometres long, but the rock eruptions were restricted to a small area in a mountainous region 13 km from the epicentre.

When the dust settled, deep holes pitted the ground, as though columns of rock had been blasted out. And vertical cracks split the rock faces exposed by the shifting ground.

Boiling point

The friction generated by the rock faces slipping over each other in the quake made the ground so hot that water turned almost instantly into steam, Shih-Wei Huang of the National Cheng Kung University in Tainan and his colleagues have calculated.

The steam would have crammed into cracks and cavities within the Earth, creating a pressure-cooker effect. Eventually, the pressure split the rock apart, pushing cracks upwards towards the surface. When the cracks broke the surface, the rock was fired upwards like a steam-powered piston.

The region's geology would have also powered the eruption, say Huang and colleagues. The ground near Chi-Chi is formed into a convex basin that acts as a kind of lens to focus seismic waves, concentrating the energy of the quake into a small area.

The same thing happened in the 1994 earthquake at Northridge in California, where much of the damage was concentrated in the city of Santa Monica. The Chi-Chi quake occurred at the Chelungpu Fault, where the Philippine Sea tectonic plate pushes at the Eurasian plate.

This focusing alone might have been enough to hurl boulders, the researchers say, although the well-like holes left behind suggest that the steam-powered cannon effect operated too.

Huang and colleagues make no comment on the flashes of light reported by terrified locals during the rock eruptions. But such things have been seen in other earthquakes, and are thought to be the product of rocks squeezing and rubbing together.

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GEOLOGISTS' PERIODIC TABLE DESIGNED

Clever graph shows how Earth's chemicals are linked.
2 September 2003
JOANNE BAKER

A new periodic table could soon be gracing the walls of geology classrooms. The table shows how chemical elements are distributed in nature, by sorting them according to their electrical charge rather than their weight.

Bruce Railsback redesigned the periodic table after becoming tired with pointing at the original version in class. "One day I found myself with my arms completely crossed, like a contortionist," says Railsback, who works at the University of Georgia in Athens. "I marched into my office, and began working on a better table."

The Earth's minerals are mostly made from elements that carry electrical charge, called ions. These behave differently from the neutral atoms that are listed in the original periodic table. Railsback grouped ions with similar charge according to where they are found. Some elements appear several times in the table because they can have different charges in different places. Sulphur, for example, appears four times: as S, S^{2+}, S^{4+} and even S^{6+}.

Geologists know that the properties of a mineral - such as its melting point, or how easily it dissolves in water - depend on the size, charge and structure of its ions. So ions can be grouped into families with similar chemical behaviour, which are therefore found in similar natural environments.

T here are five chemical clans in Railsback's table - representing the minerals in the soil, in the Earth's crust and mantle, and those dissolved in water, floating in the atmosphere and forming the basic nutrients of life.

Life prefers singly charged ions, such as the potassium (K^+) found in fertilizer or sodium (Na^+) in salt, whereas multiply charged ions of elements such as aluminium (Al^{3+}) or silicon (Si^{3+}) can form very resilient minerals that might only be found in the Earth's crust or mantle.

The new grid summarizes vast amounts of geochemical information in a single diagram. "I want people to see that broad patterns in geochemistry can be viewed in one framework," says Railsback.

Geologists have welcomed this colourful aide-mémoire. "It's a work of art," says Stephen Elphick, a rock physicist at the University of Edinburgh in Scotland. "It has an almost obsessive attention to detail that recalls the miniaturist painters."

Joanne Baker is a British Association Media Fellow

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PALEOCLIMATALOGIA

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- **EARTH PAGES**

WEB RESOURCES
ENVIRONMENTAL GEOLOGY AND GEOHAZARDS
GEOBIOLOGY, PALAEONTOLOGY, AND EVOLUTION
TECTONICS

Web resources
Dinosaurs galore
They are all at www.dinodata.net, seriously! Dutch enthusiast, Fred Bervoets puts a vast resource and copious links at anyone's disposal, even including a forum and a chat rooms. Technical drawings and artistic impressions of many species are there, together with guides to where specimens can be seen in museums, and major fossil sites. Skin, eggs, diet, controversies, companion species and sources for replicas……

Environmental geology and geohazards
Arsenic threat widens
The threat of arsenic poisoning from the use of groundwater (see October and December 2002 issues of *EPN*) is wider that the well-publicised delta of the Ganges-Brahmaputra rivers in Bangladesh (Pearce, F. 2003. Arsenic's fatal legacy grows. *New Scientist*, 9 August 2003, p. 4-5).

Although springs from rocks that contain arsenic-bearing sulphides, particularly mine drainages, were once the main hazard, increasing use of water from tube wells into alluvium have greatly increased the incidence of arsenic-induced ailments. This is sadly ironic, because massive investment in well boring since the 1960s aimed at reducing the endemic gastro-intestinal infections and parasites from polluted surface water in many third-world countries. Arsenic is a cumulative poison, building up to dangerous levels over several years. So ill-health, including fatal liver cancer, does not immediately appear in populations that are at risk. Areas in which metals are mined are obvious places where caution is needed in groundwater development, particularly where the ores are sulphides – arsenopyrite is a common waste mineral in gold mining. However, mines produce relatively small zones of risk. The alluvium derived from large mountain ranges, in which sulphides occur commonly in sediments and igneous rocks, pose the widest hazards. That is the case in Bangladesh. However, reports are emerging of similar problems in the Ganges flood plain in Bihar, India and Nepal, the Mekong Delta in Vietnam, lowland China and the Argentine Pampas, each affecting more than half a million people, together with lesser cases in 11 other countries, including the USA. Over a billion people world-wide have no access to clean drinking water, and a favoured solution is to develop local groundwater. The arsenic tragedy is not going to stop that necessary improvement in people's lives, but rigorous testing for chemical contaminants is now a must. Also, there are means of cheaply removing arsenic from contaminated water – it is almost totally adsorbed by the iron hydroxides that form rust when conditions are oxidising. In fact, if wells are driven into zones of oxygen-rich groundwater, dissolved arsenic is rarely apparent – part of the problem in Bangladesh is extraction from levels where groundwater has reducing chemistry.

Senile dementia and copper

The chemical constituents of drinking water vary a lot, according to where you live, and some like arsenic are widely feared. Having a well drilled into pure silica sand fed with rainwater is not the answer. Humans get a sizeable proportion of essential elements from the water that they drink, and pure water would result in deficiencies of many elements. Upper limits for many potentially harmful elements are set legally in some countries, and the World Health Organisation offers useful advice (see http://www.who.int/water_sanitation_health/GDWQ/Summary_tables/Tab2a.htm). However, little is known about the geochemistry of human health, when it lies within advised limits. Recent biomedical research reveals a possible link between copper in drinking water and Alzheimer's Disease (Sparks, D.L. & Schreurs, B.G. 2003. Trace amounts of copper in water induce {beta}-amyloid plaques and learning deficits in a rabbit model of Alzheimer's disease. *Proceedings of the National Academy of Sciences*, 14 August 2003 – online publication). Two experiments investigating the effects of high-cholesterol intake on rabbits both suggested that beta-amyloid plaques, implicated in human senile dementia, build up with cholesterol intake. Nothing too surprising in that. However, the results differed significantly between the two laboratories, one in the USA, the other in New Zealand. Trying to work out why two labs should get such different results, Larry Sparks of the Sun Health Institute in Arizona discovered that the New Zealand rabbits drank tap water, whereas his were given distilled water. The US rabbits had significantly less plaque build-up than those studied in New Zealand, so perhaps water chemistry had an input. Sparks and his colleague varied the copper content of their rabbits' water, and found that even with one-tenth the maximum safe concentration advised by the WHO, plaque built up 50% faster in the hapless animals. However, it is early days in this research. Cells possibly contain numerous mechanisms that fight off accumulation of potentially harmful elements, and perhaps the plaques implicated in Alzheimer's play such a role. One line of investigation is to check records of the incidence of Alzheimer's against local water chemistry, but both kinds of record, even in well-heeled countries like the USA and Britain, are rudimentary to say the least. If there is a risk, it is likely to be highest among people who use local well water in metal mining areas, or where bedrock includes sediments that contain high copper concentrations, sulphidic shales being a widespread example.

Source: Marx, J. 2003. Possible role for environmental copper in Alzheimer's Disease. *Science*, v. **301**, p. 905

Geobiology, palaeontology, and evolution

Iron and nickel in life's origins

The crucial step in assembling amino acids into the proteins that are central to living organisms is the formation of peptide bonds. Amino acids are found even in meteorites and seem to form abiogenically with some ease. Peptide bonds link simple amino acids into long chains that are the essence of complex proteins, but this does not happen spontaneously. The bonds form in the presence of carbon monoxide, but require some kind of catalysis. Researchers at the University of Munich, Germany have discovered that very fine-grained precipitates of iron and nickel sulphides readily perform such catalytic functions (Huber, C. *et al*. 2003. A possible primordial peptide cycle. *Science*, v. **301**, p. 938-940). This tallies nicely with one of the co-workers' (Günter

Wächtershäuser) hypothesis for the chemoautotrophic origin of life near sea-floor hydrothermal vents, where Fe, Ni and S are abundant, as is CO in the hot water that emanates from them.

Tectonics

Setting up subduction

Although they have roughly the same size and overall density, and probably very similar bulk compositions, Earth and Venus behave in very different ways. The Earth has plate tectonics, whereas radar images how that Venus has no such phenomenon. For the most part, Earth loses its internal heat production steadily and plate movements are intimately bound up with that generalised convective heat transfer. The surface of Venus has seen no significant deformation in half a billion years. In fact, that surface was probably formed by a massive blurt of magma around late Cambrian times. In some respects that is similar to the roughly 30 Ma appearance of flood-basalt volcanism on Earth, but on a scale that dwarfs large igneous provinces such as the Deccan and Siberian Traps. Quite probably, Venus builds up thermal energy in its mantle, until its release by massive partial melting. The key to Earth's behaviour seems to be the fact that its oceanic lithosphere is able to break and descend into the mantle. The gravitational force down a subduction zone is sufficient to keep plate tectonics going. But why does it start? Oceanic lithosphere is as strong as that beneath continents, and the other main force involved in plate tectonics, due to the gravitational effect of deepening sea floor as it cools away from constructive margins, is so low that it is unlikely to result in lithospheric failure. This vital, but often overlooked topic is nicely reviewed by Stephen Battersby, a consultant to *New Scientist* (Battersby, S. 2003. Eat your crusts. *New Scientist*, 30 August 2003, p. 30-33).

A possible explanation lies in the way in which the strength of the main mantle mineral, olivine, varies with the presence of water. Even minute amounts of water allow hydrogen ions to enter the olivine molecular lattice, thereby creating defects that can migrate and result in softening of the mineral. Experimental deformation under mantle conditions, carried out at the University of Minnesota, show ten-fold decrease in olivine's strength with as little as 20 parts per million of available water. Subduction at continental margins might therefore be set in motion by the weight of sediments accumulating on the ocean floor, and with time that weight increases as the continents are eroded. The other factor, perhaps bearing on the start of intra-oceanic subduction that forms island arcs, is the effect of transform faults and fracture zones that separate segments of different age and therefore density. Maybe that sets up forces that stress the oceanic lithosphere. The big problem is that the bulk of the oceanic lithosphere, is mantle rock, and when it has been left as a residue by the basalt melting at constructive margins, it is well-nigh anhydrous. To soften it demands a source of water that permeates the peridotite. An obvious source is seawater penetration, but at the depths involved any pathways seal up tightly. Possibly there are wet masses in the deeper mantle, either as a result of earlier subduction or dating back to Earth's origin. Slow convection in the deep mantle could bring these into contact with the base of the oceanic lithosphere, where their water could permeate and weaken it to the point of failure. Just an idea, maybe. However, seismic tomography, so effective at charting the distribution of hot and cold (low- and high-velocity) mantle rocks, is also able to suggest places where damp, weak rock occurs in the deep mantle. One such low-velocity blob occurs beneath the eastern seaboard of North America (maybe a relic of the Palaeozoic Iapetus subduction zone that runs parallel to the present margin), where there is, as yet, no sign of subduction. But there is little sign that the blob is abnormally hot, and in all probability it is damp. The history of tectonics suggests that no ocean remains with passive margins forever, and inevitably subduction ends up devouring it, in 200 Ma at most (the greatest age of today's ocean floor). Given time the eastern USA may rank with the Andes!

So why does Venus behave so differently? Although we cannot yet analyse any Venus rock (there are no accredited Venusian meteorites!) there is a plausible scenario. Venus is the greenhouse planet. It is highly unlikely that it ever harboured life, particularly of a photosynthetic kind which could have produced free oxygen. In the Earth's atmosphere, it is the presence of ozone in the stratosphere that gives the atmosphere its peculiar thermal structure, especially the tropopause. That marks a sudden cooling that limits the height to which water vapour can rise before freezing out. In the stratosphere temperature warms up with height, due to the minor "greenhouse" effect of ozone. Venus probably never has a tropopause, so that clouds of water vapour could rise to the outer limits of the atmosphere warmed by high CO_2 levels. In contact with ultraviolet light, water dissociates to hydrogen and oxygen, and at high levels the hydrogen leaks away to space. Any oxygen is quickly drawn down by oxidation of iron at its surface. So Venus has progressively lost all its water and as a result is a tough nut to crack, as regards forces in its interior. Earth on the other hand is a bit like a fondant chocolate…

Wandering hot spots

It was once an axiom of plate tectonics that volcanic-island and seamount chains provided robust evidence for sea-floor spreading. Jason Morgan in 1971 developed the notion, based on a pre-plate

tectonic idea by John Tuzo Wilson, that within-plate oceanic volcanic islands derived their magma from upward moving plumes in the mantle below the lithosphere. Many of them in the Pacific have extinct volcanic islands and seamounts arranged in straight chains that parallel the direction of sea-floor spreading shown by magnetic stripes. He likened their formation to the burn mark on a sheet of paper passed slowly over a candle flame. The Hawaii-Emperor chain bucks this hypothesis, by being profoundly bent from a WNW trend in its youngest part to north for ages greater than about 50 Ma. The problem is that neither leg is at right angles to the magnetic stripes, which does rather suggest that hot spots move. Hot spots have long been used as a frame of reference for absolute plate motions, but if one has moved then so might all the rest, and how they have moved would probably be independently of one another. Absolute motions then are hard to judge. The key to checking on the suspected hot-spot drift is to look at the palaeolatitude of differently aged volcanic rock samples along a chain. This has been achieved using palaeomagnetic measurements from the S-N Emperor chain (Tarduno, J.A. *et al*. 2003. The Emperor seamounts: southward motion of the Hawaiian hotspot plume in Earth's mantle. *Science*, v. **301**, p. 1064-1069). The test proved positive; the hotspot itself moved southwards between 81 to 47 Ma, while the Pacific plate was itself moving. Other tests suggest that hotspots in the Indian and Atlantic Oceans were indeed fixed for long periods, but the Pacific ones seem to have had a tendency to wander. Why that has happened is possibly connected to deep mantle flow, which might bend the plumes to which the hot spots owe their magmatic activity. Maybe their source region in the mantle shifts for entirely different reasons. Seismic tomography of the mantle has had some success in tracking the shapes of plumes, but not for relatively small ones because of its present poor resolution. One large plume that has an enormous tilt in the vertical dimension starts near the core-mantle boundary beneath the South Atlantic and hits the lithosphere in the Red Sea. No-one knows why, but its magmatic expression in the volcanic rocks of east Africa suggest that it too has moved from beneath Kenya about 50 Ma ago, across Ethiopia to its present position that fuels active volcanoes in the Afar Depression of NE Ethiopia, Djibouti and Eritrea.
See also: Stock, J. 2003. Hotspots come unstuck. *Science*, v. **301**, p. 1059-1060.
