INFORME GEOBRASIL
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Anthropology and geoarchaeology
Climate change and palaeoclimatology
Environmental geology and geohazards
Geobiology, palaeontology, and evolution
Planetary, extraterrestrial geology, and meteoritics
Sedimentology and stratigraphy
Tectonics

******As pessoas interessadas em receber nossa newsletter via mail, podem escrever para geobrasil@geobrasil.net ou revistadegeologia@yahoo.com.br pedindo sua adesão.***

ǂ CONCURSOS

Concurso Público Adjunto 40DE (Dedicação Exclusiva) para o Departamento de Geologia, Instituto de Geociências da UFRJ

Estão abertas as inscrições para Concurso Público de Provas e Títulos para provimento de 02 (duas) vagas de Professor Adjunto 40DE (Dedicação Exclusiva) para o Departamento de Geologia, Instituto de Geociências da UFRJ, as quais seguem até o dia 21 de janeiro de 2009.
Uma das vagas está setorizada para "Geologia Geral e Paleontologia" e destina-se ao atendimento do curso de Biologia recentemente criado no campus de Macaé (RJ), onde o futuro professor atuará. A outra vaga destina-se ao novo curso de bacharelado em Ciências Matemáticas e da Terra do CCMN (campus Ilha do Fundão), cuja setorização é "Geologia Geral e Mineralogia".
Para maiores informações sobre o edital, acessem o sítio: http://www.ufrj. br/detalha_ noticia.php? codnoticia= 6975
Os programas e a composição das bancas examinadoras estão disponíveis na secretaria do Instituto de Geociências da UFRJ (http://www.igeo. ufrj.br), onde serão feitas as inscrições. Contato: (21) 2598-9405 / 2598-9474 (fax) ou igeoc@acd.ufrj.br

ǂ LIVROS

Mapa do Brasil Político e Rodoviário
Mapa impresso no formato 0,87 x 1,16m.
Escala: 1:5.200.000. Formato: Dobrado.
Mapa do Brasil com divisão política em cores e continuidade cartográfica nos países vizinhos. Contém: bandeira do Brasil; bandeiras de todos os Estados brasileiros; coordenadas de localização; distância rodoviária entre as capitais; rodovias, ferrovias, portos, aeroportos; hidrovias, rios, represas, áreas de inundação; reservas indígenas; limites (país, estado); rosa dos ventos; tabela Mercosul (área, população, densidade, PIB, renda per capita, analfabetismo, população urbana) dos países integrantes do Mercosul.
Preço de tabela: R$ 15,00 - Preço de assinante: R$ 13,50
Oferta válida até 31 de janeiro de 2009

ǂ CURSOS E PALESTRAS

ABGP INFORMA SOBRE INSCRIÇÕES CURSO " SAL, GEOLOGIA E TECTÔNICA"
Prezados(as),
Boa tarde.
A ABGP – Associação Brasileira de Geólogos de Petróleo, informa que o valor para efetivar a inscrição no short course sobre o tema "SAL, GEOLOGIA E TECTÔNICA", que será ministrado nos dias 24, 25 e 26 de março de 2009, no IBP/RJ, das 8:00h as 17:00h, pelos Drs. Webster Mohriak, Peter Szatmari e Sylvia dos Anjos, será de R$ 1.500,00 reais.
O patamar no qual a sua empresa se encontra afiliada, lhe dará descontos ou gratuidade proporcionais na sua inscrição.
Gentileza contactar-nos a fim de finalizar o seu processo de inscrição, visto que já nos encontramos com poucas vagas.

Seguem os dados bancários da ABGP para o depósito:
Banco: Real
Agência: 0452
C/C: 1719464-5
Favorecido: Associação Brasileira de Geólogos de Petróleo.
CNPJ: 01.178.068/0001-28
Haverá uma Nota Fiscal à disposição de sua empresa ou pessoa física na sede da ABGP, no IBP/ RJ, assim que recebermos a confirmação de seu depósito, que deverá ser enviada por email.
Desde já, agradeço a sua atenção no aguardo de um breve contato.
Cordialmente,
Mônica Figueiredo S. Tauil
Diretora Executiva de Eventos e Novos Projetos - ABGP/AAPG-EUA
+55 21 2215-2353
+55 21 9463-1947
Av. Almirante Barroso 52/21º

ǂ ÍNDICE DE NOTÍCIAS

ǂ AMBIENTE BRASIL

Biochar melhora o solo, sequestra carbono do ar e produz energia. Produto ainda está sendo pesquisado pelos cientistas.
06 / 01 / 2009 Hora oficial brasileira é reajustada em um segundo
Decisão do Bureau Internacional de Pesos e Medidas é necessária para corrigir diferença entre os relógios atômicos e o tempo astronômico, gerado pela rotação da Terra.
06 / 01 / 2009 Subsolo de Marte pode ter condições para surgimento de vida
Cientista destacou a importância da missão próxima da ESA a Marte para o estudo dessas condições.
06 / 01 / 2009 "Astro" de novela, touro Bandido morre vítima de câncer de pele
Touro Bandido morreu em Barretos, vítima de câncer de pele e com cerca de 600 kg, bem longe dos 1.100 kg que já chegou a ostentar.
07 / 01 / 2009 Para auxiliar fusão celular, pesquisadores dão uma de cupido entre células
Procedimento é muito útil nas pesquisas biomoleculares. Mas reunir duas células para fundi-las é tarefa difícil.
07 / 01 / 2009 Tigres são transferidos por causa da chuva em SC
Animais foram levados para canil em Maringá, no Paraná. Eles estavam em circo situado em área atingida pelas enchentes.
08 / 01 / 2009 Cientistas filmam sapo raro pela 1ª vez
Cientistas da Sociedade Zoológica de Londres filmaram pela 1ª vez o anfíbio púrpura.
08 / 01 / 2009 Emissão de gás carbônico no País vai triplicar até 2017
Análises do próprio governo indicam que emissões saltarão para 39 milhões de toneladas em 2017.
08 / 01 / 2009 Litoral paulista tem 35 praias impróprias para banho
Segundo a Companhia de Tecnologia de Saneamento Ambiental, a alta temporada e as chuvas que atingiram parte do litoral nos últimos dias são as principais causas da poluição fecal nas praias.
09 / 01 / 2009 Vibração das asas do Aedes pode ajudar no controle da dengue
Batida das asas para o acasalamento pode ajudar cientistas no controle da população de mosquitos.
09 / 01 / 2009 Lei das Águas completa 12 anos
A lei nº 9433/97 que instituiu a Política Nacional de Recursos Hídricos no Brasil e criou o Sistema Nacional de Gerenciamento de Recursos Hídricos fez 12 anos na quinta-feira (8).
09 / 01 / 2009 Minc rebate críticas de secretário da gestão de Marina
O ex-secretário executivo do MMA, João Paulo Capobianco, afirmou que Carlos Minc foi derrotado no acordo para que a emissão de enxofre do diesel caia de 500 partículas por milhão para 50, e tenta dizer que foi vitorioso.
09 / 01 / 2009 Multas por crimes ambientais aplicados em Mato Grosso passam de R$ 1 bilhão
O recordista em irregularidades detectadas foram as queimadas, seguido do desmatamento.
10 / 01 / 2009 Nasce o primeiro bebê britânico sem o gene do câncer de mama
Casal optou por embrião selecionado para não ter o gene BRCA1, que aumenta em muito o risco da doença.
10 / 01 / 2009 Volta a chover em Santa Catarina
As chuvas devem se intensificar em todo o estado.
Europa congela, mas mundo está ficando mais quente, diz ONU
Segundo a organização, os estudos do clima desde 1850 mostram um aumento inegável na temperatura.
Lobão anuncia aumento da importação de gás boliviano, mas diz que não houve

recuo
A decisão contraria medida tomada também na sexta-feira (9) quanto à redução do uso diário de gás nos limites atuais de 19 milhões de metros cúbicos por dia.
Alagoas ganha Atlas Eólico para orientar investimentos em energia alternativa
Atlas foi o primeiro a ser realizado no país usando prospecções in loco dos ventos.
Operação apreende mais de 140 aves silvestres no ES
Foram apreendidos curiós, espécie com risco de extinção no Estado, pixoxós e papagaios Chauã, ambos ameaçados no Brasil. Também foram identificados dez proprietários de animais com anilhas falsas.
Cientistas fazem imagem de raro mamífero venenoso
As imagens foram feitas em meados de 2008, durante uma expedição à República Dominicana.
Eletricidade fatal
Número de mortes por raios no Brasil em 2008 foi o maior da década, segundo levantamento do Inpe. Ao todo foram 75 vítimas, contra 47 em 2007.
Temporais devem atingir 14 estados
A Secretaria Nacional de Defesa Civil orienta a população para evitar áreas de alagamentos e para o risco de deslizamentos de encostas, morros e barreiras.
Municípios gaúchos atingidos pela seca têm prejuízos superiores a R$ 8 milhões
De acordo com a Defesa Civil do estado, 56 municípios decretaram situação de emergência e 90 mil pessoas foram afetadas pela estiagem.
Volta a chover em Santa Catarina
As chuvas devem se intensificar em todo o estado.
Mais de 800 estipes de palmito apreendido são doados pelo Ibama no Pará
O palmito havia sido apreendido na última terça-feira (6) no Distrito Industrial, no município de Ananindeua, por meio de denúncia feita ao Linha Verde.
Incêndio destrói área de mata no Recife
Bombeiros ficaram até a madrugada desta sexta no local. Causas do fogo ainda não foram identificadas.
Nasce o primeiro bebê britânico sem o gene do câncer de mama
Casal optou por embrião selecionado para não ter o gene BRCA1, que aumenta em muito o risco da doença.
Cientistas criam técnica que acelera regeneração de tecidos
Combinação de drogas 'pode induzir medula a liberar mais células reparadoras'.
Terremoto de 4,5 graus atinge o sul da Califórnia/EUA
O U.S. Geological Survey mediu o terremoto como de magnitude 4,5 na escala Richter e epicentro localizado perto de San Bernadino, 88 km ao leste de Los Angeles com uma profundidade de 8,6 milhas.
Abelhas 'invadem propriedades' e causam transtorno nos EUA
Polinização não desejada causa aparecimento de sementes em tangerinas; apicultores e agricultores brigam.
Biólogos decifram canção de amor do mosquito da dengue
Estudo diz que mosquito Aedes aegypti, antes do sexo, ajusta batimento das asas para produzir zumbido na mesma frequência.
Zona de risco de febre amarela atinge 109 cidades no RS
A decisão de ampliar a área foi tomada depois de exames laboratoriais comprovarem que a causa da morte de um macaco em Júlio de Castilhos, na semana passada, foi a febre amarela.
Aquecimento terá efeito devastador sobre agricultura
Segundo estudo, se não houver adaptação, metade do mundo enfrentará uma grande escassez de alimentos.
Greenpeace e WWF pedem que UE aposte em combustíveis renováveis
Organizações pediram à União Européia a redução da dependência energética e o

incentivo às energias renováveis em seu território, ante a crise do gás entre Rússia e Ucrânia que já atingiu vários países europeus.
Peixe desenvolve espelho nos olhos para ver no escuro
Espécie que vive a mil metros de profundidade é único vertebrado com espelhos.
Sobe para 66 número de cidades em situação de emergência em MG
Foram confirmadas 24 mortes em decorrência das chuvas. Nesta quinta (8), houve registro de alagamentos em três municípios.
17 municípios do ES pedem estado de emergência
Chuvas afetam várias regiões do Estado.
Lei das Águas completa 12 anos
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Minc rebate críticas de secretário da gestão de Marina
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Minc pretende acelerar as concessões de florestas
A idéia do ministro Carlos Minc é fazer do Serviço Nacional de Florestas uma autarquia, com regras bem claras, para aumentar a oferta das florestas brasileiras, já autorizadas no plano de manejo sustentável.
Proprietários rurais que mantêm área de preservação maior que a exigida pela lei poderão ser compensados
Detentores dos Certificados de Reserva Florestal que não tiverem sido alienados, podem receber R$ 50 por hectare até o limite de 200 hectares.
Multas por crimes ambientais aplicados em Mato Grosso passam de R$ 1 bilhão
O recordista em irregularidades detectadas foram as queimadas, seguido do desmatamento.
Descoberta nova forma de induzir produção de células-tronco
Segundo cientistas, técnica poderia contribuir na recuperação de ataques cardíacos e fraturas em ossos.
Descobertas proteínas envolvidas no envelhecimento
Segundo os cientistas, alterar ou reduzir dois processos poderia impedir, ou retardar, a aparição das rugas.
Frio em Berlim cria réplica de habitat natural para Knut
Um dos mais rigorosos invernos dos últimos anos na capital é aproveitado pelo mais famoso urso da cidade.
Avião faz 1º voo com biocombustível de algas nos EUA
Boeing da Continental usou mistura de biocombustível e combustível normal.
Nova Zelândia: 1,5 mil assistem autópsia de tubarão
De acordo com o site do museu de Auckland, a autópsia serviu para conscientizar as pessoas sobre a ameaça de extinção da espécie.
Manter ônibus espacial antigo custará US$ 3 bi por ano
Barack Obama tinha sugerido adiar aposentadoria da nave até que substitutas tivessem sido desenvolvidas.
Cientista diz ter descoberto como pterossauros voavam
Animais decolavam com impulso das quatro patas, de forma semelhante aos morcegos vampiros de hoje.
Rio Grande do Sul amplia área de risco de febre amarela
O número de municípios do Estado da zona de risco passou de de 87 para 99 depois de mais uma morte.
Vibração das asas do Aedes pode ajudar no controle da dengue
Batida das asas para o acasalamento pode ajudar cientistas no controle da população

de mosquitos.
14 comunidades quilombolas são reconhecidas no Maranhão
Com a medida, o país passa a ter 1289 comunidades com população remanescente de quilombos, onde vivem pessoas descendentes de negros e escravos.
Emissão de gás carbônico no País vai triplicar até 2017
Análises do próprio governo indicam que emissões saltarão para 39 milhões de toneladas em 2017.
Governo quer dobrar usinas poluentes
Plano Decenal de Energia prevê a criação de 82 usinas termelétricas de 2008 a 2017, com potência total de 15.305 MW. Dessas, 68 serão movidas a combustíveis fósseis.
Acordo aperta o cerco ao comércio de madeira ilegal na Amazônia
Acordo entre o Ministério do Meio Ambiente, o Ibama e a Caixa Econômica Federal vai exigir comprovação de legalidade das madeiras utilizadas em empreendimentos financiados pelo banco.
Cientistas filmam sapo raro pela 1ª vez
Cientistas da Sociedade Zoológica de Londres filmaram pela 1ª vez o anfíbio púrpura.
Formiga dada como extinta reaparece em universidade de Minas Gerais
Inseto era considerado primeiro de seu grupo a ser eliminado pelo homem. Descoberta mostra como é difícil determinar extinção de formigas.
Chega a 61 número de cidades mineiras em situação de emergência
Ao todo, 23 óbitos foram confirmados em decorrência dos temporais. Mais de 53 mil pessoas ficaram desalojadas desde o início das chuvas.
Litoral paulista tem 35 praias impróprias para banho
Segundo a Companhia de Tecnologia de Saneamento Ambiental, a alta temporada e as chuvas que atingiram parte do litoral nos últimos dias são as principais causas da poluição fecal nas praias.
Cientistas brasileiros trazem gelo da Antártica para estudar mudanças climáticas
O material será analisado no único laboratório de glaciologia do país, na Universidade Federal do Rio Grande do Sul.
Um dia com o mínimo possível de água: você conseguiria?
Segundo o Unicef, uma pessoa precisa de, no mínimo, 20 litros de água por dia para para preservar seu bem-estar físico e dignidade referente à higiene pessoal.
Rio Grande do Sul confirma morte por febre amarela
500 mil doses de vacina foram distribuídas a moradores de áreas de risco. Novo caso suspeito foi notificado em Porto Alegre e será analisado.
Cientistas testam resfriamento isolado de cérebro
Técnica pode limitar os danos ao cérebro após um ataque cardíaco.
Gaivotas 'patinam' em porto britânico congelado
Temperaturas de até 12 graus negativos levaram à emissão de alerta para motoristas.
Japão quer que Austrália barre abastecimento de navio ativista
O 'Steve Irwin' está seguindo a frota baleeira japonesa e vem sendo acusado de pirataria pelo país.
Sol entrará em período de menor atividade, preveem cientistas
Menor atividade pode expor os astronautas a um maior perigo, diminuindo quantidade de energia disponível.
Astrônomos criam 1º modelo 3D de explosão de estrela
Imagem será ferramenta útil para o estudo da vida dos corpos celestes.
Consórcio europeu ampliará lançadores de satélites em 2009
Consórcio espera pôr de cinco a oito satélites em órbita.
Droga feita com animal transgênico deve ser aprovada
Medicamento anticoagulante feito de leite de cabra seria o primeiro do tipo a ser

aprovado nos EUA.
China entra em alerta após morte de mulher por gripe aviária
A mulher de 19 anos de idade morreu contaminada pelo vírus H5N1 depois de matar nove patos.
Vietnã confirma novo caso de gripe aviária em menina de oito anos
Doente vive em província a 150 km da capital do país asiático. Na mesma região, morreram cinco pessoas afetadas no ano passado.
Crise econômica ameaça luta contra as doenças de origem animal
Em geral, 75% das doenças emergentes que acometem o homem têm origem animal, e algumas delas, como a febre do vale do Rift, ampliam sua difusão devido ao aquecimento climático.
Questão da gripe aviária está longe de encerrada, diz OMS
Diretor-geral da organização cobrou nesta quarta-feira (7) que os países não desistam de lutar contra a doença.
Casos de dengue em São Paulo caíram 93% em 2008
Dos 222 municípios paulistas que apresentaram registros no ano passado, apenas 15 tiveram 100 casos ou mais.

ǂ JORNAL DA CIÊNCIA

Edição 3677 - Notícias de C&T - Serviço da SBPC

1. Publicada lei complementar que institui a Superintendência do Desenvolvimento do Centro-Oeste (Sudeco)
2. Orçamento dos institutos federais terá 20% reservado à formação de professores
3. TCU vê irregularidades em 16 universidades federais
4. Unifesp esclarece notícia sobre a lista tríplice para escolha do reitor da Universidade
5. 250 mil professores de SP terão aula sobre regras ortográficas
6. Para Haddad, novas regras ortográficas afetam pouco o cotidiano do brasileiro
7. Designados os membros da Câmara Técnica Interministerial voltada para o aperfeiçoamento das leis do Bem e de Inovação
8. Criada a Comissão Mista Permanente sobre Mudanças Climáticas
9. Calor extremo pode virar regra em 2100
10. EUA cobram que Brasil aceite maior fiscalização de seu programa nuclear
11. Distorção matemática
12. Fapemig: Solicitação de apoio a eventos começa a ser feita pelo AgilFap
13. Parceria vai revitalizar Parque D. Pedro II em São Paulo
14. Raios passaram a matar mais no Brasil
15. Longevidade é resultado de falha celular, afirma estudo
16. Biólogos decifram canção de amor do mosquito da dengue
17. Indiferença é reação padrão ao racismo
18. Todo o rebanho de Noronha será vendido
19. Democracia eletrônica é tema da revista de divulgação científica Click Ciência
20. Nova série de TV pela internet discute nanotecnologia
21. Universidade de Brasília ganhará ouvidoria
22. "Ciência Hoje On-line": Nova hipótese de ocupação das Américas
23. I Workshop do Departamento de Química Orgânica do Instituto de química da Unicamp
24. Fiocruz-Minas inscreve para pós-graduação em Ciências da Saúde
25. Inscrições para Pós-Graduação em Geodinâmica e Geofísica na Universidade Federal do Rio Grande do Norte

26. Mestrado em Psicobiologia da Universidade Federal do Rio Grande do Norte
27. Mestrado e doutorado no Instituto de Física da Universidade Federal da Bahia
28. Vagas para docentes no Instituto de Estudos Sócio-Ambientais da Universidade Federal de Goiás
29. Tome Ciência, neste fim de semana: Favelas sem preconceito

Edição 3676 - Notícias de C&T - Serviço da SBPC

1. Tabatinga, AM: pólo de intercâmbio da ciência com países vizinhos
2. Divulgados os campi que compõem os 38 novos institutos de tecnologia
3. MEC rejeita lista tríplice para escolha de reitor da Unifesp
4. Ciência ameaçada, artigo de Luiz Eugenio de Araujo Mello
5. Fapeam lança Pappe Subvenção para micro e pequenos empresários
6. Instituto Chico Mendes de Conservação da Biodiversidade (ICMBio) regulamenta critérios para autorização de licenciamento ambiental
7. Lei das Águas completa 12 anos
8. Energia poluidora, editorial da "Folha de SP"
9. Enigma no ar, consequências na terra
10. Mau tempo impede volta de pesquisadores brasileiros do interior da Antártica
11. Inpe busca chefe para centro regional de pesquisa
12. Museu Exploratório de Ciências da Unicamp lança edital internacional para projeto de sua sede
13. São Paulo vai testar modelo de gestão de escolas de Nova York
14. Procuradoria exige mais docentes em tempo integral
15. Um instigante laboratório político, artigo de Cândido Grzybowski
16. Pesquisador comenta matéria "País 'exporta' fóssil de novo pterossauro"
17. Estrela em disparada faz escultura no céu
18. Experimento detecta sinal cósmico misterioso em frequências de rádio
19. Levitação quântica
20. Estudo liga obesidade a câncer
21. A relação entre gordura, longevidade e reprodução, artigo de Fernando Reinach
22. Efeito colateral
23. Gene enfraquece implante dental
24. RS registra 1ª morte por febre amarela depois de 43 anos
25. Sem ar no topo do mundo
26. Paixão duradoura, artigo de Suzana Herculano-Houzel
27. Inovação será tema de programa de rádio do Sebrae
28. Ciência e Arte nas Férias começa nesta sexta-feira para 130 estudantes, em Campinas
29. "Ciência Hoje On-line": Radiação ultravioleta afeta camarões

ǂ MUNDOGEO

MundoGEO 10 Anos: o plano de modernização da Rede Brasileira de Monitoramento Contínuo
Agrimensura, Cartografia e Cadastro

Consórcio Geoespacial Aberto e OSGeo assinam memorando de entendimento
Geoprocessamento e GIS

MundoGEO 10 Anos: GEOBrasil Summit bate recordes de visitação e negócios
GEO Summit Latin America

Administração de aviação dos EUA publica documento com especificações do sistema WAAS
GNSS (GPS, Galileo, Glonass e Compass)

MundoGEO 10 Anos: a geomática e a monitoração de grandes estruturas
Agrimensura, Cartografia e Cadastro

Seminário GEOWEB & GPS debate valor da localização nos negócios
GeoWeb, GIS Móvel e Web Mapping

Imagem abre inscrições para novo programa de estágio para a área comercial
Oportunidades de Trabalho

Faltam três semanas para começar o Fórum Internacional de Mapeamento Lidar
Imagens de Satélite e Sensoriamento Remoto

Spectra Precision lança receptor GNSS para aplicações RTK
GNSS (GPS, Galileo, Glonass e Compass)

ǂ CIENCIA PORTUGAL

Destaque

Investigadores da FCTUC identificam microalgas com potencial de produção de biodisel

Produzir biodiesel a partir de óleos de microalgas com fins comerciais é o objectivo de uma equipa de investigadores da Faculdade de Ciências e Tecnologia da Universidade de Coimbra (FCTUC), que identificou 6 microalgas com enorme potencial de produção de biodisel.

Últimas Notícias

* Investigadores identificam extracto natural para tratamento da malária cerebral e do cancro

* UAlg discute técnicas de controlo de qualidade de frutos e legumes

* Ano Internacional de Astronomia 2009

* Nações Unidas proclamam 2011 como Ano Internacional da Química

Títulos de Imprensa

* Europa sem gás

* Vendas da Xbox360 da Microsoft atingem as 28 milhões de unidades

* Há iguanas cor-de-rosa nas Galápagos que Charles Darwin não viu quando andou por lá

* O ano científico em números

Eventos a Não Perder

* 1as Jornadas de Ciência Vocal sobre "Formação Contínua de Profissionais da Voz"

* Curso de Formação "Acreditação em Laboratórios e a NP EN ISO - 17025:2005"

* Conferência "Astronomia e Ciências Espaciais 2009"

* Workshop "Membranes in Medicine"

Oportunidades

* Bolsa de Investigação - Bioquímica/Biologia

* Bolsa de Investigação - Engenharia Electrotécnica

* Bolsa de Investigação - Matemática Aplicada/Engenharia Electrotécnica e de Computadores

* Bolsa de Técnico de Investigação- Física/Ciência de Computadores/Engenharia Electrotécnica

⸸ SCIENCE

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Internal Differentiation of the Archean Continental Crust: Fluid-Controlled Partial Melting of Granulites and TTG-Amphibolite Associations in Central Finland
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Technology, culture and migration in the Middle Palaeolithic of southern Africa

January 2009

The period between 300 and 30 ka was critical for the evolution of modern humans. Our mitochondrial DNA indicates that fully modern humans emerged around 200 ka. Projectile weapons that help define the epoch first appeared. Clear signs of self-adornment and symbolism also turn up during the Middle Palaeolithic. All of these developments took place in Africa, and the last two are reflections of the increased efforts by archaeologists in the continent from which we all originated. There is a long way to go to match the density of sites from which later periods in human history have been outlined in Europe, but progress is accelerating. One great hindrance has been dating sites, for the Middle Palaeolithic lies in a time zone where the Ar-Ar and 14C methods are ineffective. A developing chronological 'workhorse' for this difficult period depends on the way in which exposure of sand grains to sunlight 'heals' the defects in their molecular structure formed when radioactive isotopes in soils emit ionising radiation. Artificial illumination of sand grains containing these defects causes them to luminesce. The degree of luminescence is related to the time over which the defects have built up. Optical dating relies on grains having been exposed at the surface for a time to 'reset' the luminescence clock, and then being buried so that new defects can accumulate. Having lots of sunlight and a superabundance of bare sand, Australia has become a hotbed of research into optical dating of events associated with its peopling during the last ice age. Expertise developed there has been applied to many Middle Palaeolithic sites in Southern Africa (Jacobs, Z. et al. 2008. Ages for the Middle Stone Age of Southern Africa: Implications for human behaviour and dispersal. Science, v. 322, p. 733-735).

Archaeological work in South Africa and Namibia has revealed two distinct stone industries in the Middle Palaeolithic, both of which made hafted weapons that would have made hunting more efficient than the whatever weapons were used in earlier times – the most distinctive of the preceding Lower Palaeolithic tools was the bifacial hand axe, whose use is obscure. Both cultures involved the earliest recognisable ornamentation, such as shell beads and materials engraved with symbols, together with indirect evidence for the use of hematite and goethite pigments for body painting (see When and where 'culture' began in EPN of November 2007). Genetic evidence famously places modern human origins and their global migration out of Africa within this time frame. So, dating the archaeological sites as accurately as possible is a crucial importance, and a tremendous start has been made by the multinational team lead by Zenobia Jacobs of the University of Woolangong in Australia. Optical ages span 90 to 30 ka, with clusters between 71.9 to 71 ka and 64.8 to 59.5 ka, with a statistically significant gap of about 6.7 thousand years between them. When compared with climatic-change indicators from the Antarctic ice record the developmental episodes do not seem to correlate clearly with any specific warm of cool periods, though the earlier spans the time of the Toba super-eruption in Indonesia and the later one was a period of warming. So any environmental cause for the technological and cultural changes is unclear. However, both fall within the estimated time span of the genetic 'bottleneck' between 80 and 60 ka, and the most likely times for the initial 'Out of Africa' migrations, probably across the Straits of Bab el Mandab linking Eritrea and Arabia across the Red Sea shallowed by ice-cap linked falls in global sea level.
Childhood and families

January 2009

Human females are unlikely to break 10 seconds for the 100 metres because of their sashaying gait. It can't be helped, being due to the evolution of the pelvic girdle of bipedal females to deal with birthing of infants with increasingly large heads. Supposedly, the human female pelvis is now close to the limit that will permit walking on two legs. Such problems do not plague other living primates partly because their young have small heads relative to their bulk, and pelvic anatomy is not constrained by an habitually upright gait. It seems not to have been an 'issue' for australopithecines either: they did not possess 'child-bearing hips'. The intermediate species, Homo erectus, despite having a 1 Ma fossil record (maybe as long as 1.8 Ma for the Asian form) only recently provided substantial pelvic remains (Simpson, S.W. et al. 2008. A female Homo erectus pelvis from Gona, Ethiopia. Science, v. 322, p. 1088-11092). In the words of the authors, this pelvis is 'obstetrically capacious' and demonstrates that female skeletal evolution responded to increasing foetal brain size: it would have permitted infants with heads 30 to 50% of the adult size to have been born. Homo erectus has been widely supposed to have had a tall willowy frame analogous to that of fully modern human inhabitants of tropical savannahs, yet the Gona woman was stocky. So, environmental influences seem to have had less of an evolutionary role than the advantages of greater brain development before birth. That places H. erectus even more firmly on the human line; indeed greater in utero brain development seems to have taken place than in modern humans.

The Gona pelvis demands re-evaluation of how foetal and childhood development has progressed over the last two million years (Gibbons, A. 2008. The birth of childhood. Science, v. 322, p. 1040-1043), the unique attributes having appeared during the evolution of our own genus. Among chimpanzees, infants can fend for themselves, with a little help from elders, after 3 years old. Street children from Asia and South America need to be 6 before they can survive without parental care. Growth lines on teeth that appear week by week reveal that previous age estimates for a number of immature australopithecines whose first adult molars had erupted were large overestimates: instead of 6 they point to 4 years old. Another signal feature of human development is the lengthy period to full development (marked by the eruption of the 3rd molar as well as the end of significant growth in stature). The average age when human child bearing begins is around 19, while chimpanzees start at about 11. A fresh examination of the famous Turkana Boy's skeleton, an H. erectus, that uses tooth microstructure reduces his age at death from 13 to 8, suggesting an earlier onset of independence than in modern children. He grew much more quickly too, and would have reached adulthood somewhat earlier: around 14.5 years old. The picture with Neanderthals is not completely clear, some tooth studies suggest that their children grew significantly more quickly than modern ones, other studies point to the same rates or even longer development if adult brain sizes of Neanderthals are taken into account (larger on average than those of modern humans). Using average life expectancy of gatherer-hunter humans and chimps who survive dependent childhood – 45 and 70 years respectively – along with evidence for child development, suggests that australopithecines could have reached 45 while H. erectus adults could have expected to reach 60 years old.

There are other differences that begin to slot into space with the new data. Both human and chimpanzee females have a similar child-bearing period of around 20-25 years. The difference is that, on average, the natural interval between births is about half as long for human mothers as for chimpanzees. The greater number of human offspring gives a greater chance of the survival of some to reproduce themselves. On the other hand, slower child development places a greater burden on mothers, even

after weaning. So there is quite a contradiction between the evolutionary effects, if only child-mother relationships are taken into account. This contradiction was resolved, to some extent, by a seminal paper in the late 20th century by a group of anthropologists from the Universities of Utah and California (see O'Connell, J.F., Hawkes, K. & Blurton Jones, N.G. 1999. Grandmothering and the evolution of Homo erectus. Journal of Human Evolution, v. 36, p. 461-485). They focussed on the potentialities of the early onset of infertility or the menopause among women relative to its appearance among female chimpanzees, which gives, on average, a 30 year non-child-bearing period to older women. This approximately coincides not only with child-rearing periods for their daughters, but for their granddaughters as well. The 'grandmothering' hypothesis for human development centres on the great evolutionary advantages of post menopausal women assisting with child rearing. O'Connell et al. suggested that this arose among H. erectus, as far back as 1.8 Ma, and the Gona pelvis together with other new views of H. erectus development add considerable weight to that concept. As well as freeing younger women for food gathering, the cultural significance of older women caring for children adds another dimension that may link to the advantages of delayed post-weaning development that we see today, albeit in many annoying contexts!

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Climate change and palaeoclimatology
Mantle rock and carbon dioxide sequestration

January 2009

The peridotite mantle sequence of ophiolites often shows signs of having been altered by processes that form calcite and magnesite ($CaCO_3$ and $MgCO_3$) veins. It is a mundane feature and few geologists have paid it any heed, other than to note the veining. Such theories as there are generally suggest that the veining took place at the time of obduction of the ophiolitic masses onto continental margins, which was generally accompanied by some metamorphism. Nonetheless, the veins must have taken up carbon dioxide from some reservoir, either hydrothermal fluids derived from seawater or groundwater, but ultimately from the atmosphere: there are no primary carbonates in ophiolites. Dating the veins was deemed impossible, but someone had a go at veins in the Oman ophiolite using the 14C method (Keleman, P.B. & Matter, J. 2008. In situ carbonation of peridotite for CO_2 storage. Proceedings of The National Academy of Sciences of the USA, v. 105, p. 17295-17300), discovering a great surprise; the veins are very much younger than the Eocene age of ophiolite emplacement. Their ages span 1.6 to 43 ka, about the same as the period over which a surface tufa deposit formed. Calcite and magnesite form by the breakdown of olivine and clinopyroxene in the presence of slightly acid water in which CO_2 is dissolved, their young ages suggesting the veins formed during weathering by rainwater, the tufa deposits probably forming through related processes. Keleman and Matter estimated the volume of veins in peridotites exposed in new road cuttings at about 1%. The 15 m thick weathering horizon in the exposed Oman peridotite therefore corresponds to about 1012 kg of CO_2, which accumulated at an average rate of around 4 x107 kg of CO_2 per year. If this could be increased by 100 thousand times, the Oman peridotite could sequester about 10% of anthropogenic emissions. Is that possible?

Higher temperatures could speed up the carbonation reactions. The reactions are exothermic and sustaining a temperature around 185ºC is feasible by stimulating the reactions through shallow drilling and pumping carbon dioxide and water into

shattered rock. Interestingly, the reactions might be capable of limited geothermal power generation. The potential absorption by such a plant in the Oman ophiolite could be up to 1 billion tonnes of CO2, and there are many other ophiolites rich in olivine. But that is not the end of the story: other olivine breakdown reactions involving water generate hydrogen, as discovered by Australian hydrogeologist Gordon Stanger. While conducting his PhD field work in Oman as part of the Open University Oman Ophiolite Project, Stanger discovered natural springs from which hydrogen gas was bubbling (Stanger, G. 1986. The hydrogeology of the Oman mountains. Unpublished PhD thesis, The Open University, Milton Keynes, UK).

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Environmental geology and geohazards
Arsenic risk in the Mekong Delta of Cambodia

January 2009

Since the awful discovery in the 1980s that millions of people in the delta plains of the northern Indian subcontinent were at risk of chronic arsenic poisoning if they drank water drawn from wells in alluvium, that hazard has been found to exist in other alluvial areas close to sea level. The arsenic is of natural origin and is released when iron hydroxide, the most common sediment colorant and powerful medium for adsorption of many elements including arsenic, breaks down. Iron hydroxide is destabilised in strongly reducing environments, when its component Fe3+ gains an electron to become soluble Fe2+. The most common source of reducing conditions is vegetation buried in alluvial sediments. In Bangladesh and West Bengal, India, the problem is peat layers buried by rapid sedimentation since about 7 thousand years ago that filled channels cut by rivers when sea level was much lower during the ast glacial maximum. The risky areas in the Mekong Delta are more complex (Papacostas, N.C. et al. 2008. Geomorphic controls on groundwater arsenic distribution in the Mekong River Delta, Cambodia. Geology, v. 36, p. 891-894). Areas at risk are strongly focused by recent landforms associated with channel migration, rather than extending across entire flood plains as in Bangladesh. Features such as meander scrolls, point bars and islands that have grown to be incorporated in older floodplains show the highest arsenic concentration in groundwater. These accumulate organic debris in large amounts, whose decay releases arsenic from iron hydroxide veneers on sand grains. Older features of the same kinds show less arsenic contamination in their groundwater, suggesting that eventually either the reductants become exhausted or available arsenic is flushed out. So, careful mapping and dating of fluviatile geomorphology may be a means of screening for arsenic risk in the Mekong and other low-lying delta plains.

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Geobiology, palaeontology, and evolution
Broody dinosaurs

January 2009

The most likely ancestors of birds evolved in the Jurassic from a group of nimble and mainly carnivorous theropod dinosaurs known as Deinonychosaurs, which included the now famed Velociraptor. One of the oddest fossils ever found was the skeleton of one of these preserved together with eggs of what were originally thought to have been laid by Protoceratops. This Mongolian animal, seemingly caught in the act, was given the name Oviraptor or ‘egg seizer’. Specimens of Oviraptor and closely related

dinosaurs found subsequently show them sitting on eggs; clear evidence of bird-like brooding. If this wasn't a sufficient surprise, the clutches were enormous: 20 to 30 eggs. Detailed study of the skeletons shows that they are all males (Varricchio, D.J. et al. 2008. Avian parental care had dinosaur origin. Science, v. 322, p. 1826-1828). About 90% of all living bird species involve males in care of chicks, including sharing of incubation (5% of mammals share parental care). However, only among ratites (ostriches and the like) and tinamous do males brood eggs clutches continuously. This behaviour is generally associated with polygamy and large clutches. So the misnamed Oviraptor and its kin were not only progenitors of birds but may well have passed on the peculiarities of avian parenting.

Molecular evidence for the environment of the universal ancestor

January 2009

If ever there were a 'holy grail' for palaeobiologists, it would be the nature and ecology of the original beings from which all life on Earth subsequently evolved. That is, the primitive organism – among perhaps many that were extinguished 'intestate' – whose genetic 'footprint' alone survived to be common to all three domains of modern life: Archaea, Bacteria and Eucarya. For some time, attention has focused on extant heat-tolerant Archaea and Bacteria species (hyperthermophiles; ? 80ºC)) found in hot springs, whose genetics seem primitive. This, together with other features such as the adaptation of heat-shock proteins to other functions and the abundance of metals at the cores of other widespread proteins, has led to notions that life originated under high-temperature conditions such as those around sea-floor hydrothermal vents. The ongoing explosion in nucleic acid analysis and software to sift through vast amounts of molecular data from many sources potentially may provide the key to more concrete ideas of the origin of Earth's life. A recent comparative study of both ribosomal RNA and protein sequences among representatives of all three of life's domains gives a clue to surprises ahead for palaeobiologists (Boussau, B. et al. 2008. Parallel adaptations to high temperatures in the Archaean eon. Nature, v. 456, p. 942-945). 'Exobiologists', who nurture great, but perhaps folorn, hopes of being alive and sentient when extraterrestrial life forms are 'bagged' may also find themselves perplexed; such is the fate of hubris without substance.

The team of francophone biochemists claims that their analyses show signs of a two-fold adaptation to changing environments during the earliest period of surviving life. Rather than having emerged from high-temperature conditions, the last common universal ancestor, or LUCA, probably adapted to more temperate conditions (? 50ºC), the hyperthermophile Bacteria, Archaea and Eucarya evolving from it. Heat tolerance then declined as the later mass of life forms developed. Sadly, the authors do not address the issue of deep ocean-floor origins in their discussion, preferring to speculate about Archaean climate change and rather odd notions about adaptation to high-temperature meteoritic ejection from extraterrestrial sources. It may be that they too are in for surprises when more mature investigations hit the press.

When bacteria became more sturdy

January 2009

It's easy for geologists to forget that most of the genetic diversity on Earth is and always has been in organisms that rarely if ever fossilise; those with only a single cell, among the Archaea, Bacteria and Eucarya. All that is known is from those still alive, and they occupy a vast range of environments, most of which are not 'friendly'

to multi-celled eukaryotes. Unsurprisingly, they don't look very different from one another; just tiny bags full of water and a tiny amount of complicated biochemistry. They become distinct from their molecular make-up and also from what they do and where they live, some tending to reproduce best within the bodies of eukaryotes, such as ourselves sometimes with no noticeable effect, sometimes beneficially, but most spectacularly when they make us ill. Bacteria and Archaea have long histories, so their genetic material and proteins are easily distinguishable from group to group. This makes them amenable to the use of a 'molecular clock' approach in seeking out when and how they evolved. Analysis of these differences among more than 250 species of bacteria in the context of their living in water or under terrestrial conditions has thrown up some surprises (Battistuzzi, F.U. & Hedges, S.B. 2008. A major clade of prokaryotes with ancient adaptations to life on land. Molecular Biology and Evolution, doi:10.1093/molbev/msn247). Two thirds seem to stem from a common ancestor that had colonised the land around 3.2 Ga ago, 800 Ma before preservation of the first undisputed fossils. To live on the continental surface, all have to have evolved or inherited resistance to environmental hazards such as drying out, UV radiation and high salinity. Many pathogenic bacteria belong to the Gram-positive group, whose cell walls are distinctly adapted to terrestrial life. Despite having to live in eukaryote-free world for a billion years or more, their ancestors were especially well-suited to infesting multi-celled life when it emerged, and to being notoriously adaptable when they are threatened with toxicity themselves.

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Planetary, extraterrestrial geology, and meteoritics
So, when did the core form?

January 2009

Sometime early in its history the Earth underwent two gigantic redistributions of its chemistry: a gargantuan collision that formed the Moon; separation of a metal plus sulfide core from a silicate remainder. These 'set the scene' for all subsequent geological (and perhaps biological) evolution. The current theory about core formation stems from a marked disparity between Hf-W and U-Pb geochronology of the mantle. The first suggests a metal-secreting event about 30 Ma after formation of the Solar System – tungsten is siderophile and would have become depleted in the mantle following segregation of a metallic core. The second points to lead partitioning into a sulfide mass descent to the core around 20-100 Ma later; assuming that lead is chalcophile. The key to explaining the disparity and validating the dual core formation hypothesis lies in establishing just how chalcophile lead is, relative to other metals that are present in the mantle (Lagos, M. et al. 2008. The Earth's missing lead may not be in the core. Nature, v. 456, p. 89-92). The German and Russian geochemists set up experiments to determine directly the partition coefficients of lead and the other 'volatile' elements cadmium, zinc, selenium and tellurium between metal, sulfide and silicate melts at mantle pressures. They found that Pb and Cd are moderately chalcophile and lithophile, but never siderophile; Zn favours silicate melts, and is exclusively lithophile under mantle conditions; Se and Te are both chalcophile and siderophile, so would enter the core in both molten sulfide and metal.

The measured partition coefficients give a basis for comparing the relative proportions of the volatile elements estimated in the mantle with those predicted by the two-event model of core formation. This elegant approach strongly suggests that

sulfide or iron-nickel metal segregation from the mantle to the core can explain neither the mantle abundances of the five 'volatile' elements nor the lead-isotope ratios in the mantle. It even questions the existence of terrestrial sulfur in the core. The postulated Moon-forming mega-impact alone could have produced the measured geochemical features of the mantle as a result of vaporisation of 'volatile' elements.
Mantle heat transfer by radiation

January 2009

After some early speculation about efficient heat transfer in the mantle by radiation, it became generally accepted that convection and conduction dominate at depth in the Earth. Yet the Stefan-Boltzmann law has the radiant energy flux of a body increasing proportionally to the fourth power of its absolute temperature. So at deep mantle temperatures of up to 4300 K radiation ought to be significant unless mantle minerals become opaque at high pressures. Mantle mineralogy is dominated by iron-magnesium silicates that adopt the perovskite structure. High-pressure experiments with perovskites reveal surprisingly high transparency to visible and near-infrared radiation (Keppler, H. et al. 2008. Optical absorption and radiative thermal conductivity of silicate perovskite to 125 gigapascals. Science, v. 322, p. 1529-1532). It seems that a higher than expected radiative contribution to heat transfer should stabilise large plume structures in the zone above the core-mantle boundary.

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Sedimentology and stratigraphy
Cycling on Mars

January 2009

High-resolution remotely sensed data (HiRISE) from the Red Planet is free of charge to registered investigators (it did cost quite a bit to acquire), whereas the Earthly equivalent costing would set you back at least US$25 per square kilometre (for Quickbird. They are wonderfully clear, as Mars's thin atmosphere causes no haze except during dust storms. They are also in stereo, providing both 3-D views and digital terrain elevation data with a precision of 1 m. HiRISE data have revealed detail equivalent to that from aerial photos of Earth taken from about 5 km above. Not surprisingly, they show a lot of geology, including an area around 500 to 1000 km2 with clear signs of layered sediments (Lewis, K.W. et al. 2008. Quasi-periodic bedding in the sedimentary rock record of Mars. Science, v. 322, p. 1532-1535). Where large craters have exposed sequences in their walls it is possible to measure bedding thickness and count individual strata. In Becquerel crater the layering is very regular, comprising two size ranges around 3.6 and 37 m, the second being made up of several of the first sized layers. The two sets of thickness remain consistent through about 300 m of section, so probably represent cyclical processes on Mars. The most likely driving forces are rotational and orbital, as they are for the Earth's Milankovich climatic pacing. The 10:1 ratio between the two frequencies of bedding is twice that dominating the Milankovich time series (rotational precession and orbital eccentricity). One possibility for the Martian cycles is the estimated variation of orbital eccentricity on 120 ka, 1.2 Ma and 2.4 Ma timescales, although axial tilt changes through tens of degrees; far more than does that of the Earth's rotational axis. Thankfully, the authors stick to variations in wind-driven sedimentation to explain the bedding cycles. Changes in insolation on Mars would affect condensation and evaporation of CO2 ice at the poles, and consequently the

density of the atmosphere and its ability to move and deposit sediment. Less fortunately, they suggest water must have been involved to lithify the layers. That hardly seems necessary on a planet with low atmospheric pressure, as unconsolidated wind-blown loess in western China maintains the integrity of its layering with little cementation.

Snowball Earth challenged again

January 2009

Nobody doubts that in the Neoproterozoic there were several massive climate changes that brought frigid conditions to low latitudes. Some demand that the Earth then entered a runaway cooling because the increased albedo cause by continental ice cover would have reflected away a large amount of solar radiation; the Snowball Earth hypothesis is that the entire planet then became icebound. Evidence for the global glacial epochs is in the form of sediments clearly influenced by deposition of debris carried by ice. Later glacial episodes of Late Ordovician and Carboniferous-Permian age left thin tillites – lithified boulder clay - on glaciated land surfaces in northern and southern Africa and other parts of the southern continents, but the main evidence for the much deeper chills of late Precambrian age are thick piles of sediment studded with dropstones from floating ice. These are glaciomarine diamictites as opposed to tillites. Philip Allen and James Etienne of Imperial College, London and Neftex Petroleum Consultants of Abingdon, UK have paid particular attention to the Neoproterozoic diamictites of Oman (Allen, P.A. & Etienne, J.L 2008. Sedimentary challenge to Snowball Earth. Nature Geoscience, v. 1, p. 817-825). These prime candidates for typical products of low-latitude frigidity are over 1 km thick, and therefore require massive supply of precipitation to drive the large ice flows that could transport such large amounts of sediment. Moreover, within the sequence are many sediments that show little sign of glacial influence yet abundant signs of water transport, such as deltaic bedforms. Other strata are marine and contain ripples formed by wave action; a process that would be impossible with total ice cover. Cyclicity is present, as it is in other Neoproterozoic diamictites. That suggests repeated climate change. Snowball Earth aficionados, and others besides, claim just two and possibly three cryogenic episodes in the Neoproterozoic, but Allen and Young point to the wide range of maximum and minimum ages for those diamictites that are amenable to absolute dating. They suggest that, apart from glaciers being able to develop on land at lower latitudes than in subsequent glacial epochs, the late Precambrian was not 'special, being merely a period of prolonged climate instability akin to those of later times paced by astronomical factors.

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Tectonics

Are sheeted dykes significant?

January 2009

More than abyssal sediments, pillow basalt, differentiated gabbro and depleted peridotite sheeted dyke complexes have long been a primary identifier for oceanic lithosphere preserved in ophiolites. That assumption has recently been questioned (Robinson, P.T. et al. 2008. The significance of sheeted dyke complexes in ophiolites. GSA Today, v. 18 (November 2008), p. 4-10). Ian Gass first discovered units made up solely of dykes that intrude one another with no intervening screens of other host rocks in the Troodos ophiolite of Cyprus in 1968. Sheeted dyke complexes became widely regarded as characteristic of extensional, sea-floor spreading environments

connected to basaltic magma chambers, each increment of extension being filled with magma. They have also been imaged in eroded walls of ocean fracture systems and cut through by ocean drill cores, supporting this notion. In fact, many ophiolites are devoid of sheeted complexes, despite having all the other components of mafic-ultramafic lithosphere. Robinson et al. argue that sheeted dykes only form where spreading rates and magma supply are balanced, as expected at true constructive plate margins but far less likely at other extensional zones associated with plate tectonics, such as those in back-arc basins above subduction zones. Even at true spreading centres that generate new ocean floor magma supply may not balance extension, for instance where spreading rates are slow. Moreover, a great many ophiolites show geochemical affinities that are more akin to supra-subduction magmatic processes than those that produce mid-ocean ridge basalt.
Plate tectonics in time and space

January 2009

Seismic tomography becomes increasingly revealing as the capacity of supercomputers grows. On top of that, more sophisticated software allows present-day mantle cross sections to be reverse modelled with surface plate motions to reconstruct an idea of mantle dynamics back to Mesozoic times. Geophysicists at the California Institute of Technology give a taste of the possibilities from the subduction history of North America (Liu, L. et al. 2008. Reconstructing Farallon plate subduction beneath North America back to the Late Cretaceous. Science, v. 322, p. 934-938). Investigating 3-D evolution is the key to connecting rigid plate tectonics and fluid convection that has long been postulated but remains obscure. However, while reasonable reconstructions of global plate motions are possible using sea-floor magnetic stripes that go back to the Cretaceous, seismic tomography only images the mantle's present structure. So it might seem that generating a 3-D 'geomovie' is more of an expensive illusion than a model of past realities.

The logic behind the modelling is that today's mantle temperature structure – that is what tomograms show – stems from past plate activity. For instance, a deep cold, slab-like anomaly dipping eastward beneath eastern North America can reasonably be inferred to be a relic of the Farallon Plate, which formerly constituted floor of the eastern Pacific. That plate was subducted beneath the west edge of the continent until around 40 Ma, when the East Pacific Rise that had driven it was subducted. The present thermal structure shown by the tomogram has, in a sense, 'faded' as a result of thermal relaxation of the original anomalies by heat diffusion. Choosing geologically reasonable starting conditions for long-term evolution of a mantle segment enables iterative forward modelling to try and achieve the present set-up. While there is an element of circularity in this logic, such a dynamic model has a predictive aspect; i.e. as cold, dense material in the mantle sinks it tends to pull the surface downwards, allowing marine flooding of continental interiors. During the Late Cretaceous this did happen spectacularly in North America, and Liu et al's model shows this. Yet sea level also rose globally at the time, thereby amplifying the inundation. Although geeomodellers will be excited by Liu et al's developments, it is modelling and even the simplest of models is acutely sensitive to the chosen starting conditions, as meteorologists with vastly more real data at hand have discovered again and again.
See also: Steinburger, B. 2008. Reconstructing Earth history in three dimensions. Science, v. 322, p. 866-868