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NEWS METEORITICA DA SEMANA

Mina de diamante na Russia

<http://www.dailymail.co.uk/news/article-2204566/Russia-diamonds-Source-Siberian-asteroid-crater-supply-world-markets-3-000-years.html>

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AMBIENTE BRASIL

Cientistas apontam turismo como ameaça à biodiversidade na Antártica
Continente recebeu mais de 130 mil turistas nos últimos quatro verões. Transmissão de gripe de humanos para aves é um dos riscos.

Estátua gigante do faraó Amenhotep III será restaurada e exposta no Egito
Blocos do monumento são retirados de templo mortuário no sul do país. Após recuperação, peça deve ser colocada em pedestal e virar atração.

Dilma promulga protocolo de acordo ambiental entre países do Mercosul
De acordo com o protocolo, o país que enfrentar uma emergência ou ameaça ambiental deve comunicá-la imediatamente aos outros Estados-Membros, para prevenir, inclusive, que chegue aos seus territórios.

Governo chinês cogita proibir churrascos contra poluição do ar
Medida valerá apenas para as zonas urbanas. País enfrentou níveis alarmantes de poluição em janeiro.

Estudo quer provar que ocupação humana data de 7 mil anos, em RO
Sítio Arqueológico do Teotônio tem grande quantidade de 'terra preta'. Pesquisa recente aponta que ocupação ocorreu há mais de 3 mil anos.

ONU diz que ameaça de meteoros exige coordenação mundial
Na sexta-feira passada, um asteroide atingiu a região de Chelyabinsk, na Rússia, causando danos e ferindo muitas pessoas.

Com Harrison Ford, ONG anuncia centro de sustentabilidade para as Américas
O objetivo do centro é agregar de uma forma mais ampla e regional iniciativas bem-sucedidas de sustentabilidade que já estejam

acontecendo nesses países.

Exposição a repelente pode deixar mosquito da dengue insensível
Inseto ignorou substância DEET 3 horas após ter contato com ele. Substância diminuiu sensibilidade do sistema olfativo, diz estudo.

Milionário da reciclagem chinês lidera protesto contra empresas poluidoras
Chen Guangbiao organizou manifestação em Nanquim, no leste do país. Meta é envergonhar companhias e conscientizar sobre a qualidade do ar.

Moscas-das-frutas dão álcool como medicamento para a prole
Cientistas descobriram que fêmeas depositam os ovos em um ambiente alcoólico para proteger descendentes de vespas parasitas.

Filhote de peixe-boi ferido é resgatado em igarapé no interior do Amazonas
O animal, de 14 kg e 53 cm, parece ter sido vítima de algum predador. Por ser muito novo, animal deverá demorar a voltar para águas livres.

Abelhas e flores se comunicam por sinais elétricos, aponta estudo
Plantas emitem impulsos a insetos polinizadores que sugam pólen e néctar. Cores vivas e fragrância das flores também ajudam a atrair esses animais.

Poluição por nitrogênio no solo sobe 60% em 20 anos na China, diz estudo
Alta concentração de substância prejudica vegetação, entre outros efeitos. Aumento da atividade agrícola e industrial causou elevação do nitrogênio.

Lua de Plutão pode ser nomeada em homenagem a 'Star Trek'
Duas novas luas foram descobertas recentemente e ainda não têm nome. Nome 'Vulcano' recebeu cerca de 30% dos votos entre 21 opções.

Brasil desenvolve modelo próprio de análise de mudança climática
Sistema simula o clima em todo o planeta entre 1960 e 2100. Dados produzidos serão repassados a painel internacional.

Cientistas propõe Antropoceno como nova era geológica
Marcas da civilização caracterizariam época antropocena, onde homem e natureza são indivisíveis: uma nova era de responsabilidade.

Mantenedouro não tem autorização para reproduzir felinos, diz Ibama
Justiça determinou que 12 tigres fizessem vasectomia no Paraná. Veterinário explica que sua procriação não ajudaria a preservar espécie.

Nova Zelândia: pinguim "perdido" é encontrado a 2 mil km de casa
Ele teria deixado sua casa, na Ilha Macquarie, próxima da Antártica, no início de fevereiro, e nadado até as proximidades de Wellington, capital neozelandesa.

Presidente da Bolívia lança Ano Internacional da Quinoa na ONU
Grão milenar ajudaria a combater crises alimentares, segundo Evo Morales. Presidente ainda criticou empresas que freiam desenvolvimento da planta.

Manaus lidera as estatísticas de casos de dengue no Amazonas
O período de chuvas no Amazonas favorece o aparecimento de focos do *Aedes aegypti*, mosquito transmissor da doença. Onze municípios estão sendo monitorados.

Pesquisa identifica menor planeta já encontrado fora do Sistema Solar
Exoplaneta Kepler 37-b é rochoso e não tem atmosfera nem água. Tamanho do planeta é semelhante ao da nossa Lua.

Extrair metais no espaço pode ser rentável em até 30 anos, diz cientista
Encontro na Austrália discute possibilidades futuras na Lua e em asteroides. Transportar 1 kg de material à Lua custaria atualmente quase R\$ 200 mil.

Ativistas pedem intervenção naval da Austrália após confronto com baleeiros
Choque entre navio japonês Nisshin Maru teria danificado dois navios do grupo Sea Shepherd durante embate nas águas da Antártida.

Meteorito gigante atingiu a Austrália há 360 milhões de anos, diz estudo
Objeto media entre 10 e 20 km de diâmetro e abriu cratera no sul do país. Testes mostram que rochas apresentam marcas de impacto extraterrestre.

Área da Antártica ocupada pelo Brasil tem solo contaminado, aponta estudo
Amostras do local onde está Estação Comandante Ferraz foram analisadas. Cientistas recomendam raspar solo no lugar de base destruída por fogo.

Pesquisa explica como foca pode dormir com metade do cérebro
Animal deixa a outra metade acordada quando dorme na água. Cientistas sugerem que neurotransmissor é chave para comportamento.

Homem é preso após postar imagens com filhote de espécie protegida
Imagens mostram um homem e duas crianças levantando, brincando e sentando em um filhote de peixe-boi na Flórida (EUA).

Fundadores de Google e Facebook criam prêmio para cientistas

Anúncio dos ganhadores aconteceu nesta quarta-feira (20). Cada vencedor receberá U\$ 3 milhões - quase o triplo de um Nobel.

Pesquisa encontra ruínas de pirâmide sobre túmulo de vizir do Antigo Egito

Construção possuía 15 metros de altura, afirmam arqueólogos. Vizir trabalhou para faraó egípcio Ramsés II, dizem cientistas.

São Paulo assina acordo com governo federal para implantar Cadastro Ambiental Rural

Com a adesão de São Paulo, chega a 19 o número de estados que estabeleceram parceria com o governo federal para construção do cadastro, que se tornou obrigatório com a aprovação do novo Código Florestal.

Maiores cidades do Brasil devem participar de pesquisa global sobre mudanças climáticas

Belém (PA), Belo Horizonte (MG), Brasília (DF), Campinas (SP), Curitiba (PR), Fortaleza (CE), Goiânia (GO), Porto Alegre (RS), Recife (PE), Rio de Janeiro (RJ), Salvador (BA) e São Paulo (SP) receberam em janeiro o convite para participar.

Governos de países em desenvolvimento terão recursos para desenvolver economia verde

Pela primeira vez, as quatro principais agências internacionais das Nações Unidas ligadas ao meio ambiente, ao trabalho, ao desenvolvimento industrial e à pesquisa vão trabalhar juntas para garantir a implementação de políticas sustentáveis como as de tecnologias limpas e de erradicação da pobreza.

Países reunidos no Quênia discutem rumos de órgão ambiental da ONU

Relatório do Pnuma lançado em evento aponta preocupação com o Ártico. Degelo pode causar corrida por exploração de petróleo, diz órgão da ONU.

UnB inaugura primeira estação de 'GPS' russo no hemisfério ocidental

Estação de monitoramento entrou em funcionamento nesta terça (19). Equipamento na universidade permite correção de posicionamento global.

Peixe com radiação elevada é fogado a 200 km de Fukushima, diz emissora

Cooperativas já haviam suspendido vendas como medida preventiva. Usina nuclear no Japão sofreu acidente após tsunami ocorrido em 2011.

Ecoturismo contribui para preservação da vida selvagem na Namíbia

Milhares de turistas chegam ao país para conhecer as belezas naturais do deserto. O turismo sustentável é cada vez mais procurado. Ele estimula investimentos em energias renováveis e preservação da biodiversidade.

Organização do Tratado de Cooperação Amazônica pretende monitorar desmatamento da Amazônia

O governo brasileiro pode ser um dos principais colaboradores da medida, mas cada nação vai poder adaptar o monitoramento às suas necessidades e a realidade da Amazônia presente em cada território.

Senadores vão visitar canteiros para fiscalizar andamento das obras da transposição do Rio São Francisco

Após audiência pública na terça-feira (19), na qual receberam representantes de algumas das empresas que executam as obras, os senadores decidiram ir fiscalizar in loco o Eixo Norte, no dia 8 de março, e o Eixo Leste, no dia 22 de março.

Nasa anuncia tempestade solar mais forte até agora em 2013

O incremento nas atividades solares no domingo (17), porém, não causou maiores transtornos à Terra.

Justiça manda castrar doze tigres de mantenedouro em Maringá/PR

Justiça acatou normativa do Ibama, que prevê a esterilização de felinos. Sentença foi publicada na sexta-feira (15) e ainda cabe recurso.

Chineses se revoltam contra poluição das águas por grandes empresas

Segundo um recente relatório do Ministério de Recursos Hídricos divulgado pela agência oficial Xinhua, 64% das 118 cidades analisadas têm seus lençóis freáticos "muito poluídos", contra 33% que estão "levemente poluídos" e apenas 3% que possuem água limpa.

ONU lança alerta sobre impacto de produtos químicos do dia a dia

Estudo aponta efeito hormonal que pode ser provocado por aditivos em embalagens, bens de consumo, produtos farmacêuticos e de higiene.

Petrobras começa a produção de petróleo no Campo de Baúna, na Bacia de Santos/SP

A plataforma, do tipo FPSO - unidade flutuante que produz, armazena e transfere petróleo - está conectada ao Poço 9-SPS-88, que tem potencial de produção de 12 mil barris por dia.

'Babá' de ursos cuida de 27 filhotes órfãos nos Estados Unidos

Animais foram abrigados por Ben Kilham em floresta próxima à sua casa. Região que serviu de 'berçário' tem 32 mil m², segundo agências.

Após interrupção, comunicação entre a Terra e a ISS é restabelecida

Durante pouco menos de três horas, estação espacial ficou incomunicável. Seis astronautas a bordo estão bem.

Nasa busca sistemas mais eficazes de alerta antecipado de asteroides

Meta é ver objetos com antecedência para evitar danos como os da Rússia. Agência diz que quedas como essa ocorrem só uma vez a cada 100 anos.

Clima tem esforço unificado

Governo federal reúne representantes de 13 estados. Em pauta, a redução das emissões de gases poluentes no país.

Interpol prende 194 em operação contra desmame na América Latina
Polícia disse que esta é a primeira operação internacional neste sentido. Outros 118 estão sob investigação em 12 países, incluindo o Brasil.

Vírus surgido em 2012 está adaptado para infectar humanos, diz estudo
Micro-organismo foi registrado no Oriente Médio e já matou cinco. Pesquisa afirma que remédios disponíveis podem controlar a doença.

A vez dos eletroeletrônicos
Edital define critérios para o recolhimento correto de computadores e afins.

ONU diz que derretimento do Ártico tem efeitos globais diretos
Publicação anual da ONU aponta a redução das geleiras como o problema ambiental mais preocupante de 2012.

Exportações do agronegócio cresceram 14,7% em janeiro
No acumulado de 12 meses, as exportações atingiram US\$ 96,6 bilhões e o saldo comercial ficou positivo em US\$ 80,8 bilhões.

Cientistas querem usar 'adesivo' de mexilhões em cirurgias
Material que imita proteínas de mexilhão pode ser usado em medicamentos. 'Cola' seria utilizada também como indicador de mudanças ambientais.

Casas de luxo são construídas em áreas de preservação no Rio Araguaia
Força-tarefa de órgãos ambientais está fiscalizando imóveis em GO e MT. Uma das construções fica dentro do rio, com energia elétrica e até piscina.

Cientistas anunciam descoberta de água em rochas lunares
Os resultados indicam que a Lua em seu início tinha presença de água que não foi substancialmente perdida durante a sua formação.

Sucuri de 170 quilos é morta a tiros ao tentar engolir porco no Acre
Animal atacava um porco em uma fazenda no município de Feijó. Tamanho do animal chamou a atenção de todos.

Cientistas propõem destruir asteroide com sistema que usa energia solar
Projeto prevê transformar energia do Sol em feixes de raios laser. DE-Star também pode servir para estudos espaciais, dizem pesquisadores.

Chance de achar substância orgânica é "quase inexistente", diz chefe de missão em Marte
John Grotzinger foi questionado sobre se a Nasa já teria resultados positivos comprovando que o planeta teria sido habitável no passado.

México detecta vírus de gripe aviária em 12 granjas do país
Empresa diz que já sacrificou 486 mil aves com o vírus H7N3. No ano passado, doença levou ao sacrifício de 22 milhões de galinhas.

"Preparem-se para um mundo 5°C mais quente", alerta ex-chefe do IPCC
Um mundo 5°C mais quente hoje significa colheitas agrícolas em queda tanto nos países desenvolvidos quanto nos países em desenvolvimento, aumento do nível do mar ameaçando muitas cidades importantes e uma escassez significativa de água.

ANP fará rodadas de licitação para empresas de pequeno e médio porte
O objetivo da medida é aumentar a participação de empresas de pequeno e médio porte nas atividades de exploração, desenvolvimento e produção de petróleo e gás natural.

Bicycled transforma carros velhos em bicicletas
Iniciativa da Lola Madrid recicla veículos abandonados em ferro-velho e cria peças únicas, feitas à mão.

ICMBio lança obras sobre patrimônio natural do Brasil
Inicialmente, serão dois projetos editoriais que focarão, sobretudo, nas unidades de conservação federais.

Rússia inicia 'corrida do meteorito' após localização de fragmentos
Grana de rochas espaciais chega a custar até US\$ 2.200. Confirmação de que corpo celeste é meteorito foi divulgada neste domingo.

Eleição de entidades ambientalistas é definida
Representantes do setor defenderão agenda no Conselho Nacional do Meio Ambiente.

Ribeirinhos transformam riquezas da Amazônia de maneira sustentável
Árvores, sementes, raízes e frutos viram perfumes e produtos de beleza. Atividade melhora a renda das famílias e ajuda a preservar a floresta.

Cooperativa na Ilha do Marajó organiza a coleta de andiroba
Óleo da semente é comprado com regularidade pela indústria de cosméticos. Famílias conseguem uma renda extra em torno de R\$ 2.100 ao ano.

Marina Silva lança embrião de um novo partido político
De acordo com a ex-ministra do Meio Ambiente, a base do programa do futuro partido será a sustentabilidade em todas as áreas: ambiental, política, econômica etc.

Buscas por fragmentos de meteoro que caiu na Rússia são canceladas

Seis profissionais procuravam fragmentos de corpo celeste em um lago. Governo decidiu se concentrar na reconstrução das regiões atingidas.

Coleta de murumuru transforma a vida de agricultores na Amazônia
Venda de sementes e cosméticos funciona como complemento de renda. Trabalho ainda fez despertar uma nova atitude em relação à natureza.

Ator Harrison Ford visita projeto de habitação sustentável em favela do Rio
O ator, herói dos filmes Indiana Jones, é um dos diretores globais da organização não governamental Conservation International, que luta pela preservação do meio ambiente.

Técnica testada para conter HIV poderá ser usada em vacina experimental contra dengue
Transmitida pelo mosquito *Aedes aegypti*, a dengue ameaça quase 3 bilhões de pessoas no mundo.

Fenômeno solar foi visto no interior de Alagoas neste domingo
Círculo luminoso em torno sol foi registrado por moradores do interior. Halo é causado por cristais de gelo refletidos no sol, diz meteorologista.

Pesquisador alerta para problemas de saúde causados por novo aterro sanitário em Seropédica/RJ
Segundo o professor da Universidade Federal Rural do Rio de Janeiro, Cícero Pimenteira, os efeitos sobre a saúde pública serão sentidos em médio e longo prazos, com danos muitas vezes irreparáveis.

Aproveitamento ecológico do pau-rosa impede extinção da espécie
Pesquisas científicas estudam o plantio e o uso sustentável do pau-rosa. Manejo envolve a poda de apenas alguns galhos por árvore a cada ano.

Cientista da Nasa diz que busca por vida em lua de Júpiter é promissora
Lua Europa teria maior probabilidade por possuir oceano líquido sob o gelo. Robert Pappalardo, do laboratório Jet, comentou fato em evento nos EUA.

Estudo questiona eficiência do uso de ratos em testes médicos
Pesquisadores afirmam que medicamentos baseados em experimentos feitos com ratos podem não ter o mesmo resultado em humanos.

Manifestantes exigem de Obama medidas contra aquecimento global
Os participantes, que exibiam cartazes com a frase 'Qual será seu legado climático?', formaram uma corrente humana entre a Esplanada Nacional e a Casa Branca, em protesto contra o projeto do oleoduto Keystone XL, que trará petróleo do Canadá até o Texas a um custo de 7 bilhões de dólares.

FAO tem novo representante no Brasil e em Portugal
A partir desta segunda-feira (18), o cargo será ocupado por Alan Bojanic, que já liderou as atividades da organização no Chile e no escritório regional para América Latina e Caribe.

SCIENCE

Synchronous vertical and horizontal tectonism at late stages of Archean cratonization and genesis of Hemlo gold deposit, Superior craton, Ontario, Canada

Shoufa Lin and Gary P. Beakhouse
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Very high-resolution seismic stratigraphy of Pleistocene eustatic minima markers as a tool to reconstruct the tectonic evolution of the northern Latium shelf (Tyrrhenian Sea, Italy)

S. Fraccascia, F.L. Chiocci, D. Scrocca, and F. Falese
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Evidence for large-scale methane venting due to rapid drawdown of sea level during the Messinian Salinity Crisis

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Detrital zircons indicate no drainage link between southern California rivers and the Colorado Plateau from mid-Cretaceous through Pliocene

Raymond V. Ingersoll, Marty Grove, Carl E. Jacobson, David L. Kimbrough, and Johanna F. Hoyt
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EARTH PAGES

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Posted on February 19, 2013 by Steve Drury | [Leave a comment](#)

Artist's impression of the Chicxulub impact – (credit: Wikipedia)

Since 1980, when Alvarez père et fils discovered signs of a globe-affecting impact event in rocks marking the stratigraphic boundary at the end of the Mesozoic Era –between the Cretaceous and Palaeogene Periods – there has been continual bickering over the cause of the mass extinction at that time. Unlike other mass extinctions that one marked the end of an Era dominated in the popular mind by the iconic dinosaurs. Besides that focus, many geologists have been averse to external, 'wham-bam-thank-you-ma'am' explanations for shifts in the fossil record: a sort of Lyellian view that geological change had to be at the pace of the humble tortoise and must be due to something in the Earth system itself. Then a majority, this conservative faction looked instead to the effects of the voluminous basalt flood that had affected western India at around the same time. Incidentally, that apparent match to the end-Mesozoic extinction sparked an interest in volcanic associations with other mass extinctions.

Discovery by geophysicists of evidence for a large almost completely buried impact basin, about 180 km across, centred in the Caribbean off Mexico's Yucatan Peninsula swayed opinion towards an extraterrestrial cause when it became clear that the impact had occurred around the time of the K-Pg boundary, then placed at 65 Ma. Soon there were claims that the Deccan Traps had erupted in less than a million years at that time, together with doubts cast on the actual age of the Chicxulub crater. The time-spread of the Deccan volcanism enlarged with more dating to between 68 and 60 Ma; and so the to-ing and fro-ing continued, gleaning sizeable grants for entrepreneurial geoscientists keen on one or other of what were becoming bandwagon topics. Then the 'golden spike' marking the time of the mass extinction became the subject of controversy. A means of precise dating is to examine signs in sediments of cyclical climate change using the Milankovich approach, although before 50 Ma only the 405 ka cyclicity predicted from astronomy is readily detected. Using well-dated volcanic horizons to calibrate such a stratigraphic dating method might be the key, but it became apparent that 65.3, 65.7 or 66.1 Ma all seemed to have the same likelihood.

The two kill mechanisms that had been proposed are in fact very different, not merely in terms of what might have happened to atmospheric chemistry, climate, photosynthesis and so on, but concerning their timing. Repeated episodes of major basalt eruption every 100 ka or so would have had a chronic and perhaps cumulative effect on the Earth's biota; i.e. even a 10 Ma spread for Deccan basalt floods bracketing the actual die-off would be acceptable as a cause. An impact however takes no more than a second to occur, because of the hypersonic speed induced by Earth's gravity as well as that of the asteroid through the Solar System. All its immediate effects – entry flash; crater excavation; debris fall-out; atmospheric dust and toxic gas accumulation; climate change; acid rain and tsunamis – would have been done and dusted over a matter of a few thousand years. The Chicxulub impact would have been a catastrophe that was instantaneous in geological terms. Its occurrence would need to bear the same date as the mass extinction itself to be seen as incontrovertible; well, at least to the majority of geoscientists. That point seems to have been reached.

As well as the crater, Chicxulub scattered molten rock far and wide to appear in the 'boundary layer' as glass spherules, which are dateable using radiometric means. So too is the timing of the mass extinction itself, provided suitable materials can be found above and below the strata across which fossil abundances change so dramatically. Paul Renne of the University of California, Riverside, and colleagues from the US, the Netherlands and Britain dated impact glasses from Haiti and volcanic ash from the late Cretaceous to early Palaeogene terrestrial sediments of Montana, USA that bracket the extinction event using multiple argon-isotope studies and the ^{40}Ar - ^{39}Ar method (Renne, p.r. and 8 others 2013. Time scales of critical events around the Cretaceous-Paleogene boundary. *Science*, v. 339, p.684-687. The glasses come out at 66.038 ± 0.049 Ma, while the Ar-Ar age of volcanic ash just above the carbon-isotope anomaly that marks the world-wide disappearance of a large proportion of living biomass is 66.019 ± 0.021 Ma. As they say, the ages are 'within error' and the error is very small indeed.

So, does this work mark the end of the K-Pg controversy? Probably not, as very large sums of grant money are still tied up with ongoing studies. Perhaps to assuage the fears of all those still financially addicted to answering 'what killed the dinosaurs?', The abstract of the paper reads thus 'The Chicxulub impact likely triggered a state shift of ecosystems already under near-critical stress'.

Artist's impression of the common ancestor of placental mammals (Credit: Science magazine)

Interestingly, in the very same issue of *Science* came a research article that reexamines taxonomy of 86 key living and fossil placental mammals in the light of genetic sequencing, to locate stratigraphically their earliest common ancestor (O'Leary, M.A. and 22 others 2013. The placental mammal ancestor and the post-K-Pg radiation of placentals. *Science*, v. 339, p. 662-667). That seems to wrap up, for now, another controversy; did diminutive placental mammals arise unnoticed beneath the gaze of mighty dinosaurs, or what? It seems that some precursor mammals were able to diversify and produce a line whose fetuses grow and are nourished in the mothers uterus attached to a placenta, before live birth at an advanced stage of development, once opportunities for diversification emerged after the K-Pg event. Morphologically, the ancestor of everything from a naked mole rat to a blue whale and, of course, ourselves, seems to have been a sneaky-looking little beast with a long nose and pointy teeth. It does look like it, or its predecessor, could have scuttled unscathed amongst the leaf litter as dinosaurs engaged in their death prance...

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Tagged Argon dating, Cretaceous-Tertiary extinction event, Deccan Traps, K-T boundary, Meteorite impact

Update on a classic British field site

Posted on February 8, 2013 by Steve Drury | Leave a comment

Glacial erratic at Norber Brown that sits nicely on a limestone plinth, due to the erratic's having protected the limestone underneath from erosion. (credit: Wikipedia)

Few expect Earth scientists to get all sentimental, but they do. My soft spot is for one of the most rewarding and least strenuous geological sites in Britain, Norber Brow near Austwick on the southern edge of the Yorkshire Dales National Park. As well as the famous glacial erratics of Silurian greywackes perched on Lower Carboniferous limestone, 250 m to the SE by a well-trodden path is the inverse, the Variscan unconformity at the base of the Carboniferous on the very same Silurian formation. I was lucky to be taken there at age 15 by Roy Happs who taught A-level Geology, and it decided my future, there and then.

The erratics don't just sit on the limestone, but are on pedestals up to 30 cm above the surrounding limestone surface as if carefully balanced by Beowulf's assailant Grendel. Somehow, since the time glacial flow had deposited the Silurian boulders the underlying limestone had been dissolved away; but how fast was that? That is the key to the pace at which limestone pavement, to most general visitors such a stunning and unexpected feature of the Dales, might have formed. And such a delight to hear of its terminology: clints, redolent of the former Viking people of the Dales, that stand proud between deep fissures known as grikes, a suitably ominous term of unknown derivation. Such superbly fractal landforms are, of course, but one part of karst (from the eponymous region of limestone country in Slovenia).

A classic limestone pavement in the Yorkshire Dales National Park (credit: Wikipedia)

It is really satisfying to discover that a lot of cutting-edge science has recently been aimed at Norber from a substantial review in *Earth Pages'* sister journal *Geology Today* (Wilson, P. et al. 2013. Dating in the Craven Dales. *Geology Today*, v. 29 (January-February Issue), p. 16-22). The length of time that the Norber erratics have been exposed to cosmic-ray bombardment has been determined from ^{10}Be , ^{26}Al and ^{36}Cl analyses with a precision of ± 1000 years to 17.9 ka, shortly after the last glacial maximum (LGM) when warming and glacial melting had just begun in this part of Yorkshire. That might seem to indicate an average of 330 mm of limestone had been dissolved over that period to form the pedestals, i.e. a dissolution rate averaging about 20 micrometres per year, which is extremely rapid, geologically speaking. In 1962 when I was shown the site we were told that elsewhere the limestone pavement had formed since the first field systems (Iron Age) were laid out as now useless drystone walls crossed it. Roy Happs somewhat darkly suggested that they had formed since the start of the Industrial Revolution because of acid rain.

He was pretty much wrong on that score, but cosmogenic dating of the clints shows significant discrepancies between the age of deposition of the erratics and the exposure age of the clints. This suggests both chemical dissolution and also periods of frost shattering and gravel removal, perhaps by soil creep. Dating of other materials enlivens the history of local landform development. Another karstic feature is the presence of sinkholes or dolines that are often filled with yellowish silts that show clear textural evidence of being windblown sediments or loess. These aeolian sediments have long been regarded as post-LGM too, but optically stimulated luminescence dating of their quartz grains gives an age split between pre- (27.5 ± 2.6 ka) and post-LGM (16.5 ± 1.7 ka). Some loess elsewhere in Craven district comes out to be as young as 8.2 ka, to tally with evidence from Greenlandic ice cores for a sudden deterioration in North Atlantic seaboard climate during this early time in the Holocene.

Then there are the local caves, renowned in Victorian times for their cave bears and other mammal fossils. One bear skull from Victoria Cave in the Craven area gave a ^{14}C age of 14.6 ± 0.4 ka which statistically coincides with that from a cut-marked horse vertebra. More

than likely the bears were turfed out when humans reached Craven, but did they return when humans fled in the face of the Younger Dryas return to frigid-desert conditions? Probably not, as the YD would almost have sterilized what are now the Yorkshire Dales. Even earlier ages of 114 ka from U-Th dating of calcite flowstone that embeds hippo, elephant, rhino and hyena bones in Victoria Cave date to the previous Eemian interglacial. Indeed this speleothem has yielded ages as far back as the limit of the U-Th method (100 ka). On a solo expedition in 1964 I had the chance to sleep-over in Victoria Cave, but pressed on with goose bumps to the nearby Youth Hostel.

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Posted in Geomorphology

Tagged Clints and grikes, Glacial erratic, Karst, Yorkshire Dales

Geology and creationism

Posted on February 6, 2013 by Steve Drury | 4 Comments

Creationist car in Athens, Georgia (credit: Amy Watts via Wikipedia)

Creationism is a topic about which I would not normally comment for much the same reason that once prompted pub landlords to have a sign behind the bar reading 'No politics, no religion'. Yet geology has played an historically central role in the debate about Genesis vs Science. An excellent summary of how this emerged and was fundamentally resolved in favour of scientific endeavour, even if the 'Genesisists' have not been entirely rooted out, appeared in the Geological Society of America's GSA Today in November 2012 (Montgomery, D.R. 2012. The evolution of creationism. GSA Today, v. 22, p. 4-9).

Starting with Steno's break with a literal acceptance of Genesis in 1669, the dominant view grew among clerics as well as scientists – 'back in the day' often one and the same – that the Earth was far older and its history one of changing natural processes. That outlook prevailed to strengthen through the late-18th and 19th centuries. Of course there was a tendency among 'people of the Book' somehow to blend their religious and scientific views, along the line that 'scientific revelations that contradicted biblical interpretations provided natural guidance for better interpreting scripture'. But by the end of the 19th century there were very few literal creationists though a great many Christians who endorsed attempts to reconcile biblical text and geology. Yet long after the Reverend William Buckland finally admitted in the mid-19th century that his imagination had ruled his zealous quest for evidence of a Noachian Flood and abandoned a literal idea of that and other aspects of Genesis there remained a persistent dribble of creationism.

A wry view of Young-Earth Creationism (Photo credit: seriouscher)

That minor current split in the 20th century into a 'tanky' tendency that defended young-Earth creation and a global flood in the last ten thousand years, and a more 'moderate' wing of 'old-Earth' creationists. 'Old-Earthers' happily accept geological evidence of great antiquity, but maintain that God made it for eventual use by humanity; i.e. it had just sat around awaiting Adam and Eve being expelled from Eden. Both wings evolved along equally bizarre paths using a logic that boils down to a blend of perversity and simply ignoring any contrary evidence, such as that unearthed by Buckland long before. For instance when confronted by the fact that the deepest parts of the oceans contain less sediment than has accumulated on the continents, they defy gravity by insisting that ocean basins were eroded out by the Flood and then deposited with all their internal structures intact on higher ground.

Unsurprisingly, most creationists believe that there has been a centuries-long conspiracy by scientists to mislead the rest of humanity. Were it not for the fact that more than 40% of people in the United States believe in young-Earth creation, David Montgomery's account of what is now a somewhat one-sided yet stupidly lively debate as regards true evidence would be amusing. His concluding sentence, 'How many creationists today know that modern creationism arose from abandoning faith that the study of nature would reveal God's grand design for the world?' is probably one of the best ways of enraging any creationist who tries to enlighten you: he/she will certainly not just go away, but in the foam they generate you should be able to make good your escape.

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Creationism vs. Evolution: Ground-Breaking Discovery by Physics Engineer Solves Vital Facet of Origins Debate. (prweb.com)

NO! Christians do NOT believe the Earth is 5,000 years old! (mbtimetraveler.com)

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Posted in Ethics, and the philosophy and practice of science

Tagged Creationism, Flood myth, Genesis, Young Earth creationism

The production of geoscientists: a cautionary tale from the Open University

Posted on February 4, 2013 by Steve Drury | 2 Comments

Despite global recession, worldwide job opportunities for geoscientists are increasing faster than the number of available applicants. In the US the Bureau of Labor Statistics predicts 21% growth in this sector in 2010-2020 (Perkins, S. 2011. Geosciences: Earth works. Nature, v. 473, p. 243-244). That figure does not include jobs freed-up by retirement: the demographics of employed geoscientists in the petroleum and mining industries are skewed markedly to the over-40s, peaking at age 50.

The American Geological Institute's Geoscience Workforce Program has reported that the regions that produce most geoscience graduates, the US, Europe, Russia and China, are not meeting their domestic needs let alone global requirements. The demand stems from the traditional petroleum and mineral industries that are booming, together with the renewable energy sector and growing concern about environmental hazards and impacts attending global warming.

An editorial (Rare Earth scientists) in the December 2012 issue of Nature Geoscience is headlined, 'Not enough young people enter the geosciences. A passion for the subject should be sparked early on.' It then comments that the decline in young people studying the geosciences at school stems from Earth science not being taken seriously, under-education of their teachers and budgetary sacrifice of geoscience to preserve the more 'traditional' science subjects. The leading article concludes, 'On an increasingly vulnerable planet, governments need to teach the young people of their country an understanding of the Earth's basic make-up and dynamics, along with inspiring a fascination for its age and beauty. How else can we expect humanity to survive the Anthropocene?'

Creative work on the Open University campus (Photo credit: ianonline)

For over 40 years the Open University has been a key UK educator in geoscience. Since 1971 a total of about 170 thousand, mainly British students have studied at home through the OU for a science-based degree. Discovering tectonics, Earth structure, geology and

palaeontology through studying the Science Foundation Course must have been a thrilling experience because since 1972, when the OU began to offer a level-2 course in Geology, around 30 thousand of its science 'beginners' decided to find out more; an average enrolment of 760 per year. The OU's Department of Earth Sciences added more level-2 courses so that by 2000, students could also study economic geology (The Earth's Physical Resources – 18 500 students from 1974 to 2009, averaging 544 per year), planetary science (The Earth: Structure, Composition and Evolution- 14 100 students from 1981 to 2005, averaging 590 per year) and Earth-system science (Earth and Life –7121 students from 1997 to 2006, averaging 712 per year).

After 1981 Open University students could, and many did, aim for a geoscience-oriented degree that also took in three, more advanced, level-3 studies. These were Oceanography (12 121 students from 1989 to 2012, averaging 505 per year), stratigraphy (The Geological Record of Environmental Change – 7968 students from 1976 to 2012, averaging 295 per year) and Earth's internal processes (Understanding the Continents – 6994 students from 1976 to 2012, averaging 259 per year).

In this way the Open University became one of the world's largest single providers of geoscience education, if not the largest: in the whole of the United States fewer than 3000 first degrees majoring in geoscience are awarded annually. Yet from its inception the OU's Department of Earth Sciences had never claimed to be training professional geologists: had it been, its graduates would have significantly affected the world's employment opportunities in the discipline. In fact that claim could never have been made, for one simple reason: distance learning for part-time students would always struggle to provide the volume of hands-on practical training that is the quintessence of this pre-eminently field- and lab-based discipline. Nevertheless the OU's range of residential schools where practical activities were intensively provided for went a good way towards filling this gap.

Open University students at the now defunct Geology summer school, inspecting a fault. (Photo credit: Wikipedia)
So, to those unfamiliar with the realities of the OU milieu it will seem odd that in 2012 the world's largest provider of distance learning axed all residential courses right across the science spectrum, including those in practical geoscience. But to those directly involved this move was the logical final step in a series of changes since 2001. Before that, for those courses that included a residential component attendance had been compulsory, except in special circumstances. Yet after 2001 university authorities deemed that the residential schools continue only as optional components for degree study and should carry an additional registration fee. Not surprisingly, in the case of the core level-2 Geology course attendance at the re-branded residential school declined to 30% after 2001.

Two other important developments attended this change in the Earth Science degree programme. After 2001 pass rates fell abruptly. For example, in the Science Foundation Course the rate fell from an annual average of 69 to 54%, and in level-2 Geology from 65 to 55%. Because residential schools played a vital role in boosting confidence and reinforcing home studies, equally as important as transferring practical skills, this dramatic fall in performance was only too predictable.

The other post-2001 development was an across-the-board fall in new registrants for Earth Science level-2 courses, especially in those that had previously not been served by residential studies: The Earth: Structure, Composition and Evolution from a pre-2001 average of 680 per year to 470 thereafter; Earth and Life from 866 to 558; The Earth's Physical Resources from 795 to 456. The majority of those who enrolled for these courses having previously studied the core Geology course such dramatic declines are easily explained. Those who had opted out of the residential course missed its undoubted boost to confidence and enthusiasm, and reinforcement in basic geoscientific principles. More likely to underperform in the Geology course, they would not have felt equipped to deal with other level-2 courses, and 'voted with their feet'.

Since its launch, The Earth's Physical Resources course had been acclaimed by geoscience teachers internationally for having made economic geology fascinating rather than a chore. In 2005-7 it had been completely refurbished and rising registrations bucked the downward trend. Yet in 2009, it was axed with little discussion. Declining enrolment for The Earth and Earth and Life prompted management to withdraw both and combine parts of their content in a single course Our Dynamic Planet: Earth and Life. Launched in 2007, by 2012 it attracted a mere 217 applicants. In 2013 it too will be withdrawn from the curriculum.

In late 2010 the OU's Department of Earth Sciences held a celebration of its 40-year existence; yet only a year later in 2011 the department that had brought plate tectonics, advanced palaeontology, unravelling past climates, physical resources; planetary science and much besides to the widest student audience ever achieved ceased to be. It was merged into a restructured entity called the Department of Environment, Earth and Ecosystems. There seems to have been a failure of nerve and leadership that may have important consequences not only for the future of geoscience as a discipline and among the wider public but for the very knowledge necessary for our national and human survival. The future availability of remaining geoscience courses is uncertain, with all being expected to start for the last time within the next year or two. Perhaps some major transformation to meet increased needs for general public awareness of the way our planet works is being planned: let's hope so and that any new offerings have as much impact as the earlier courses did before the start of the 21st century. It will be a hard task, as the Open University tripled its fees for students entering the OU system from 2012 onwards.

NOTE: (added 11 February 2013) The Open University has been offered the right of reply to this item.

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Posted in End of year summaries, general musings

Tagged Earth science, Geology teaching, Open University

Hominin evolution becoming a thicket

Posted on January 26, 2013 by Steve Drury | 1 Comment

Scientific American is renowned for its eminently readable reviews of both emerging and perennial topics. Its February 2013 issue takes on one that is guaranteed to run and run; the evolutionary course that produced us (Harman, K. 2013. Shattered ancestry. Scientific American, v. 308 (February 2013), p. 36-43). Since its launch Earth Pages has covered much of the new science in the field but did not anticipate the depth of the stir towards which it has led.

Australopithecus afarensis reconstruction (credit: Wikipedia)

For a decade it has become increasingly clear that anatomically modern humans are unique in one respect: they are the first species in perhaps 4 million years to be the sole extant member of the cladistic tribe Hominini. As recently as 30 ka Homo sapiens shared the planet with Neanderthals, Denisovans, H. erectus and H. floresiensis. At the time the genus Homo emerged around 2.0-2.5 Ma ago there were at least four other fossil groups that shared the major characteristic of upright gait, all australopithecines in 'robust' and 'gracile' guises.

As time goes by there will likely be more fossil discoveries that show important anatomical signs of other novel evolutionary divergence, which therefore warrant new species. Pliocene-Pleistocene time is becoming crowded, and the more diversity in its fossil record the less likely it is that some clear evolutionary pathways can be devised to explain just what was going on. Katherine Harmon of Scientific American's editorial team touches on the thorny issues of upright walking and gait, tree climbing, precise use of the fingers and thumb, and brain size that are raised by 22 species; 2 living and 20 extinct.

Genetics clearly indicates that our nearest living relatives belong to two species in the genus Pan (chimpanzees and bonobos). It has been generally assumed that the common ancestor of this extant kinship some 8 Ma back was chimp-like, and that evolutionary divergence from its habits and anatomy produced the growing 'bramble patch' of hominin evolution. That assumption is based on the principle of parsimony, i.e. the simplest view of the evidence – what there is now and fragments from the past eight million years. The trouble is there is a dearth of fossils that can be said to be en route to chimps in some way.

In fact today's chimps and bonobos are more or less restricted to clambering in tropical forest habitats, for which they are well-adapted. Maybe they are the survivors of evolutionary vagaries just as complex as those leading to us. For one thing, almost embarrassingly, their brain size is substantially larger than those of quite a few fossil hominins; and why not? How they behave socially may possibly have arisen as part of their specialisation too, of which more shortly. Our big difference from them is being supreme generalists, as well as consciousness.

All the fossils classed as hominins show some signs of being able to walk upright, classically the forward position of the foramen magnum at the base of the skull where it joins to the backbone, but in some cases merely the geometry of the hip joint to the pelvis for that is all that has been found. Yet that anatomical likelihood glosses over the vital detail of the actual gait – heel-to-toe like us (Australopithecus afarensis), on the outside edge of the foot akin to chimps (Ardipithecus ramidus) or differently again but possible as efficient as us (Au. sediba). Then there is the matter of arboreal abilities: chimps are masters despite their bulk, but every hominin whose foot bones have been found shows some evidence of grasping with the big toe. Indeed humans are pretty nimble climbers but do not brachiate from branch to branch.

As regards the hands, an interesting point is that while chimpish knuckle walking is not seen in fossils, Ardipithecus probably could walk on all fours with hands flat on the ground but had fingers quite capable of precise manipulation, an ability shown spectacularly well by 2 Ma old Au. sediba. Upright walking may have evolved more than once, and it is even possible that chimps evolved specifically for climbing in forestlands, their highly adapted grasping hands only capable of knuckle walking on the ground.

Oreopithecus bambolii from the Upper Miocene of northern Italy (credit: Wikipedia)

The late-Miocene of Africa – the likely time range for the Pan-Homo common ancestor – is a fossil desert as regards primates. Yet its Italian equivalent has yielded a fascinating and well-preserved creature; Oreopithecus bambolii has skeletal features compatible with an upright posture and bipedal locomotion. Until the African Miocene yields something more appropriate, Oreopithecus is a candidate for a common ancestor, and interesting in another respect. Its dentition does not include prominent canine teeth that in the predominantly vegetarian, though occasionally carnivorous, Pan species serve well in their aggression-based, hierarchical social systems, as they do in the even more spectacular baboons.

Christopher Boehm, primate behaviouralist cum anthropologist, in his recent book Moral Origins (2012 Basic Books, ISBN-13: 978-0465020485) uses the principle of parsimony to reconstruct the social system of the Miocene Pan-Homo common ancestor from those of chimps and surviving human hunter-gatherers. His thesis is that it was centred on the hierarchical dominance of 'alpha' males, as is that of chimps. Prolonged social selection in hominin evolution largely tempered such a 'Big Man' tendency through a variety of strategies directed by majorities. Social punishments, including capital punishment, evolved to combat free-loading, theft and individual dominance in favour of cooperative egalitarianism. Such measures developed increasingly conscious self-suppression of such traits that eventually manifested themselves as what we now regard as human morals. Boehm considers that this psychological trend in evolution accelerated once Homo sapiens began hunting of large prey animals that added substantially to diet.

Aggressive male chimpanzee (Credit: Daily Mail)

There is a major problem for this view: like Oreopithecus every well-preserved hominin species, even the earliest Sahelanthropus tchadensis, do not have prominent canines irrespective of whether they show evidence of at least partial meat-eating or pure vegetarianism. For some species with many fossil members, such as Au. afarensis, there are signs of sexual dimorphism – larger males than females – but that does not necessarily signify hierarchical social behaviour. With the appearance of H. erectus that difference wanes to the present slight differences between modern male and female humans.

Aggressive male humans, note gumshields (credit: John_Scone via Flickr)

If it is valid – and who knows? – for morphology to give clues to social behaviour, then it is equally likely that the beginnings of the hominin evolutionary thicket may well have involved a trend in social behaviour towards cooperative action; 8 million years ago. For generally small, gracile creatures with habits no more threatening to the big predators of the African savannahs than that of the porcupine, there would have been a powerful selection pressure towards a united front. Of course, in the last ten thousand years since the shift to economic strategies based on storable surpluses and their expropriation, hierarchical social systems with violence at their heart emerged among modern humans. Judging by the body shapes and dentition of extant 'alphas', as in capital's boardrooms and

among the frontbenchers at Westminster, anthropology clearly is in need of some refinement...

→ 1 Comment

Posted in Anthropology and Geoarchaeology

Tagged Australopithecus afarensis, Australopithecus sediba, Hominini, human evolution, Oreopithecus, Sahelanthropus Mercury: sometimes a moist, organic-rich world

Posted on January 25, 2013 by Steve Drury | Leave a comment

Full-colour image of Mercury from MESSENGER (credit: NASA via Wikipedia)

Astronomers welcomed in 2013 by suggesting from Kepler spacecraft data that the Milky Way galaxy alone probably hosts at least a hundred billion extrasolar planets and that a potentially habitable world the size of Earth probably lies within 20 light years of ours (go.nature.com/pxgbbt). OK, so there are at least 10-15 planets out there for every person likely to be alive by the mid-21 century when the technology becomes available to judge whether or not any of them hold a shred of interest for a population facing worsening living conditions right here.

Mercury is closer and currently being peered at in considerable detail by NASA's MESSENGER mission to the Sun's closest planet. The venture seems to have justified itself – and probably JAXA/ESA's forthcoming BepiColumbo to be launched in 2015, arriving in 2022 – by showing that the long suspected 'cold traps' at Mercury's poles have indeed trapped something: ice and abundant organic debris (Neuman, G.A. and 10 others 2013. Bright and dark polar deposits on Mercury: evidence for surface volatiles. *Science*, v. 339, p. 296-300).

The planet is exceedingly rough, having been hit by objects of all sizes yet possessing insufficient internal energy to repave itself. Its axis of rotation is at a right angles to Mercury's orbital plane, much like that of the Moon, so its polar regions are perpetually short of solar radiation. Deeply shadowed places have been measured by infrared radiometry to be as cold as 25 degrees above absolute zero. Any volatile materials that might have landed in them or condensed there from earlier atmospheres might seem likely to stay there indefinitely. Not quite so, for the most likely compound, water ice, can sublimate away (shift directly from the solid to vapour state). Nevertheless, remote sensing shows the north pole region to be somewhat mottled dark and light on shadowed poleward-facing surfaces. The properties of backscattered radar beams and detection of emitted neutrons are consistent with the bright areas being water ice (Lawrence, D.J. and 12 others 2013. Evidence for water ice near Mercury's north pole from MESSENGER neutron spectrometer measurements. *Science*, v. 339, p. 292-296). First estimates give a total ice volume of around 10 to 1000 km³ compared with almost 3 million km³ in the Greenland ice cap.

It's the dark stuff that sets Mercury apart from, say, the Martian or lunar poles, the idea being that comets or icy asteroids impacting Mercury would have delivered complex organic compounds as well as water ice. This would temporarily give otherwise airless Mercury an atmosphere of volatiles parts of which might condense in the perpetually shaded parts of the polar region. Sublimation of exposed ice would have left a residue rich in those organic compounds that eventually protected deeper ice from fading away with time.

Now, imagine how supremely excited exo-planet hunters would be if they picked up such signals from a truly far-off world.

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Messenger spots Mercury performing organic chemistry (myscienceacademy.org)

Lucey, P.G. 2013. A wet and volatile Mercury. *Science*, v. 339, p. 282-283

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Posted in Planetary, extraterrestrial geology, and meteoritics

Tagged Ice, Mercury, MESSENGER, Organic material

Porphyry deposits and the fracking mechanism

Posted on January 19, 2013 by Steve Drury | Leave a comment

Porphyry sculpture of two of the four co-emperors of the late Roman Empire – the Tetrarchy (credit: mhobl via Flickr)

For about a century a style of mineral deposit that develops in and around shallow, silicic magma chambers has dominated world supplies of copper, molybdenum and, more rarely, tin. They are also enriched in other valuable elements, including gold and silver, which makes these deposits even more attractive to mine. Hosting them are fine-grained diorites and granodiorites that typically contain large crystals of quartz and feldspar set in the finer material. Technically such rocks are called porphyries; well not so technical because the name derives from many porphyries having a colour much valued by Egyptian and especially Roman sculptors and architects – a reddish purple close to that on the hem of a nobleman's toga. The dye comes from the 'purple' fish – the marine mollusc *Murex brandaris* – which the ancient Greeks referred to as porphura. In Rome, 'The Purple' were the nobles, and today they are the cardinals. The connection is coincidental, the best and most enduring rocks for sculpting and making pyramids are of this kind, but happen to be purple. Of course, there are igneous rocks with the eponymous texture but different colours, but stonemasons in the ancient world never bothered to give them a special name

The porphyritic texture signifies to virtually every geologist a magmatic history in which an igneous magma resided deep in the crust slowly crystallizing large mineral grains. Then, for one reason or another, it was blurted towards the surface. Porphyry copper and molybdenum deposits have a disturbingly phallic shape; a tall, rough cylinder capped by a bell-shaped zone of mineralisation. And they are pretty big, the largest at Bingham Canyon in Utah, USA once having been ~2.5 km tall and 0.5 km wide, with a 2 km, bell-shaped zone of mineralisation affecting the intrusion and its surrounding country rock.

The world's largest open-pit mine in the porphyry copper deposit at Bingham Canyon Utah (credit: Wikipedia)

Porphyry ores are not much for the rock aficionado to shout about and they are characterized by very low grades of ore, the metal-sulfide ore minerals and any gold being barely visible. They are economic because there is a great deal of rock with copper and molybdenum contents often less than 0.5%, and economic gold values less than a part per million (0.03 troy oz t-1). The bulk and the diversity of metals make mining porphyry deposits profitable. The ore minerals occur in tiny cracks that pervade the deposits forming a 'stockwork'. That is where this style of mineralisation has a link with fracking shales to release their gas content. Stockworks are produced by very high-pressure steam that explosively fractures every cubic metre of the orebody. Crystallisation of sulfides and barren

minerals keeps the fractures open until the system runs out of steam and mineralising fluids. Modelling of the thermodynamics associated with porphyry intrusions now suggests that once pressure and temperature stabilise at the requisite levels the hydraulic fracturing becomes self-sustaining (Weis, P. et al. 2012. Porphyry-copper ore shells form at stable pressure-temperature fronts within dynamic fluid plumes. *Science*, v. 338, p. 1613-1616). The key is the 'fracking' and as 'shells' with the right conditions migrate through the upper part of the intrusive system groundwater is drawn in to the freshly permeable rock to dissolve, transport and, where chemical conditions permit, to precipitate metals in the cracks. The modelling suggests a fundamental process that extends from plutonic systems, through volcanic edifices, hydrothermal processes in shallower rocks and active geothermal systems that vent to the surface.

Stockwork in copper-molybdenum porphyry deposit in Mexico (credit: Sundance Minerals)

In many respects the universality of hydraulic fracturing associated with increased heat flow, which itself can affect the crust repeatedly, may be the key to the concept of 'metallogenic provinces'. These are large areas in which economic mineralisation of many styles but with much the same 'blend' of metals seems to have formed again and again during crustal evolution. Such provinces emerged from exploration and mining to present explorationists with the old adage, 'To find an elephant go to elephant country'. Now there may be a theoretical basis on which new discoveries may be made.

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Posted in Economic and applied geology

Tagged Fracking, Hydraulic fracturing, Hydrothermal, Mineralisation, Porphyry copper deposit

On-line global geological maps

Posted on January 14, 2013 by Steve Drury | Leave a comment

Global geological map (credit: Commission for the Geological Map of the World)

Getting hold of geological maps on-line has been a hit or miss affair until recently, and those made available for free are at a variety of scales (generally less than 1:10 million) and vary in reliability and information content. Scanned versions of paper sheets rendered with JPEG compression can leave a lot to be desired. If you are able to pay, then the situation improves as there are on-line vendors of printed geological maps. But, all told, browsing the world's geological features is a slow and generally frustrating task. The best bet might seem to be the Commission for the Geological Map of the World (<http://ccgm.free.fr/>). They do, as you might expect, sell global maps, but at 1:50 million detail is sparse, although there is an alternative 3-sheet set (Old World, Americas and Polar regions) at 1:25 million, and it is possible to purchase digital versions and a variety of geophysical sheets. Maps at 1:5 million are available for Europe, Africa (6 sheets), the Middle East and South America plus various tectonic maps. However, to explore full planetary-scale geology at the modestly informative scale of 1:5 million demands visiting a lot of on-line vendors, as there is no one-stop shop for geologists

Small-scale extract from the OneGeology portal with 1:2 million maps for Ethiopia, Kenya, Tanzania and Uganda, and at 1:10 million covering surrounding areas (credit:OneGeology portal)

Such frustration is set to change, because in the last few years there have been moves to compile digital geology in a manner akin to Google Earth, now available at the OneGeology portal (<http://portal.onegeology.org/>). As soon as you enter the portal, the reason why the Commission for the Geological Map of the World is so irritating immediately becomes clear: the CGMW world map is what shows at the global scale and it doesn't show much. Progressive zooming-in removes the 1:50 million map, to be replaced by a compilation of regional maps at scales ranging from 1:2 million to 1:12.5 million scales that does cover the entire Earth's continental surface. A mouth-watering prospect until you start to look for legends! In fact, the associated tool box provides a means of pointing to individual stratigraphic units on the maps to get information (metadata), but whether and how it works depends on the source of the maps and the scale of viewing. For instance, the 1:10 million map of Africa gives no information, while the 1:5 million map of Europe gives quite a lot.

With a zoom to better than 1:10 million display, lots more detail appears in the form of country maps, but coverage is not comprehensive. In East Africa country maps are available for Ethiopia, Kenya, Rwanda and Tanzania – ranking with the current offerings from the USA. Moving to Europe, the range of scales improves on a country-by-country basis, generally 1:1 million to 1:250 thousand, but the UK truly grabs attention by providing digital geology at up to 1:50 thousand scale. The British Geological Survey has systematically rendered all its bedrock map data digitally to this scale, and is to be congratulated at making the 'Full Monty' available on the OneGeology portal. Full BGS metadata shows for all the visible stratigraphic and lithological units, together with faults and superficial deposits.

British Geological Survey bedrock mapping in Cumbria at 1:50 thousand scale. (credit: OneGeology portal)

It soon becomes clear that OneGeology is a work in progress, but what a work it will be! If I have a criticism it is that geology is not linked to topography and cartographic features. The ever-present base data is the NASA Blue Marble mosaic of natural colour MODIS imagery. Unfortunately, outside of areas bare of vegetation this does not have any useful lithological connection, and is presented at such a large pixel size that only the coarsest topography shows up. At scales better than 1:2 million it is an irritating patchwork of square pixels. Far better would be shaded relief based on the ubiquitous ASTER GDEM data at up to 30 m resolution, especially as it is possible to vary the opacity of the geological maps to show the link with surface morphology. Maybe that is on its way and possibly oblique perspective 3-D viewing: one has to bear in mind that Google Earth wasn't built in a day and geoscientific data are not yet standardised – a hugely costly endeavour, as that would involve not only digitising all maps but lengthy negotiations.

Most geologists are likely to be interested in maps that show rock units with stratigraphic age, but Jens Hartmann and Nils Moosdorf of the University of Hamburg, German have mined regional geological maps to assemble a global, purely lithological database (Hartmann, J. & Moosdorf, N. 2012. The new global lithological map database GLiM: A representation of rock properties at the Earth surface. *Geochemistry, Geophysics, Geosystems*, v. 13, doi:10.1029/2012GC004370) in cooperation with CGMW. Their Global Lithological Map (GLiM) consists of over 1.25 million digital polygons (ESRI shape or *.shp format), classified lithologically in three levels to give a total of 42 rock-type classes, 16 used in previous global lithological maps and two more lithologically specific sets of 12 and 14 subclasses. Though the database is said to be presentable at up to 1:3.75 million scale, the version of GLiM that the reader can download is not in vector format but as a series of cells numerically coded according to class in a georeferenced grid. Since that is 360 rows x 720 columns, i.e. 0.5 degrees of latitude by 0.5 degrees of longitude, that version is useful only for rough statistics, such as the percentage of North America that is covered by evaporates, for instance. Perhaps the most useful aspect of the GLiM paper is the comprehensive referencing

of the source maps. GLiM, apparently, is not an on-line resource, but no doubt the authors can provide interested parties with the *.shp files (contact jens.hartmann@zmaw.de or nils.moosdorf@zmaw.de)

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Fracking leaks

Posted on January 9, 2013 by Steve Drury | 3 Comments

David Cameron speaks (credit: Wikipedia)

The start of 2013 saw a massive puff from the British government for development of shale gas, Premier David Cameron crying 'Britain must be at the heart of the shale gas revolution'. Fearful of the rapidly growing shift from Britain's natural-gas self reliance to dependence on the Gulf, Russia and Norway the Conservative-Liberal Democrat coalition gave the green light for 'frack drilling' to restart. This followed a pause following seismicity in the Blackpool area that attended Cuadrilla's exploratory drilling into the gas-rich Carboniferous Bowland Shale thereabouts. There is also a nice sweetener for the new industry in the form of tax breaks.

Boris Johnson holds a model London red bus (Photo credit: Wikipedia)

London Mayor Boris Johnson, a possible contender for Tory leadership, seems pleased. And perhaps he should be, as the Lib-Con coalition will be tested because the junior partners depend electorally, to some extent, on 'green' credentials. The Lib-Dem Energy Minister, Ed Davey, seemingly favours an automatic halt to drilling should there be seismicity greater than 0.5 on the Richter scale; an energy level less than experienced every day in London from its Underground trains. Political commentators have forecast that green issues may exacerbate tensions within the coalition in the second half of its scheduled 5-year term, especially as the electorate seems set to reduce the Liberal Democrat partners to irrelevance in future elections.

Natural gas's biggest 'green' plus is that being a hydrocarbon its burning releases considerably less CO₂ than does its coal energy equivalent, the hydrogen content becoming water vapour. Yet the dominant gas is methane, which has a far larger greenhouse effect than the CO₂ released by its burning. To avoid that presenting increased atmospheric warming, extracting natural gas needs to avoid leakage. Unfortunately for those bawling lustily about the economic potential of fracking source rocks such as the Bowland Shale, recent aerial surveys over US gas fields will come as a major shock. At the annual meeting of the American Geophysical Union in early December 2012 methane emissions from two large gas fields in the western US were released (Tollefson, J. 2013. Methane leaks erode green credentials of natural gas. *Nature*, v. 493, p. 12). They amount to 9% of total production, which would more than offset the climatic 'benefit' of using natural gas as a coal alternative.

A shift from coal to natural gas-fuelled power generation would slow down climatic warming, if leakage is kept below the modest level of 3.2% of production. So if the latest measurements are an unavoidable norm for gas fields then natural gas burning in fact increases global warming. Even more telling is that, until the shale 'fracking revolution', gas was produced by drilling into permeable reservoir rocks capped by a seal rock – usually a shale. The gas would not have leaked except from the well itself. Fracking, by design, increases the permeability of what would otherwise be a seal rock – hydrocarbon-rich shale – over a large area.

Schematic cross-section illustrating types of natural gas deposits (credit: Wikipedia)

Aerial analyses to check emissions over oil and gas fields, let alone over shale-gas operations, are not widespread. However, the technology is not new. Where emissions are strictly enforced in populated areas, as over oil terminals and refineries, overflights to sample the air have been routine for several decades. Little mention is made of such precautionary measures in the promotion of fracking.

Another point is that as well as often being far from habitations, US shale-gas operations are generally into simple stratigraphy and structure. The Lower Carboniferous Bowland Shale now being touted as fuel for Britain's escape from a descent into economic depression, with its estimated 200 trillion cubic feet of as potential, is intensely faulted and broadly folded, having experienced the Variscan orogeny at the end of the Palaeozoic Era. The complexity and pervasiveness of this brittle deformation is amply shown by geological maps of former coalfields that incorporate subsurface information from mine workings. The Bowland Shale lies below the Upper Carboniferous Coal Measures, many of the likely targets for fracking have never been subject to intensive underground mining simply because the Coal Measures were eroded away tens of million years ago. Consequently the degree to which many fracking targets may be riven by surface-breaking faults and fracture zones is not and possibly never will be known in the detail needed to assess widespread methane leakage.

Sometime in early 2013, the British Geological Survey is set to release estimates of the Bowland Shale gas reserves, in which its detailed mapping archives will have played the major role. That report will bear detailed scrutiny as regards the degree to which it also assesses potential leakage.

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Posted in Economic and applied geology, Environmental geology and geohazards

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Publishing: is it worth the effort?

Posted on December 31, 2012 by Steve Drury | Leave a comment

A measure of the esteem in which a peer-reviewed paper is held is supposedly the number of times to which it is referred in other papers. Of course, the older a paper is the more chance that such citations will have built up; but the annual rate of citation is likely to

fizzle out over time. Papers that create a frisson of initial excitement and command enduring citation are few and far between: they probably launched a new line of inquiry.

It is instructive to try to nail Alfred Wegener's influence in tectonics using the Web of Science, which ought to have been pretty high. Superficially, he had none and is remembered through that arm of Thomson Reuters for six papers: four on atmospheric physics – his speciality; one on lunar craters and a sixth on the patterns of cracking seen on rotten wood. These give him a mere 20 citations. Wegener's posthumous problem was that *Die Entstehung der Kontinente* first appeared in the fourth issue of *Geologische Rundschau* in 1912, and seemingly the Web of Science doesn't have that journal in its archives of a century ago. Later, extended editions appeared in book format which were not peer reviewed (most geoscientists would not touch his ideas with a barge pole until long after his death in 1930), and are therefore outside the academic pale. The key to a plausible mechanism for continental drift – symmetrical magnetic striping above ocean basins – was first described by Fred Vine and Drummond Matthews in an issue of *Nature* in 1963. In 50 years their work, ranking with discovering the structure of DNA, has accumulated 709 citations; i.e. 38.5 citations per year on average, which is not much for fuelling a revolution.

Alfred Wegener, the unsung hero of continental drift (credit: Wikipedia)

Of course, citation is not the same as the frequency at which a paper is read. It is no secret that a not inconsiderable number of papers that appear in published reference lists haven't been read by the authors who cite them. They are there by proxy, and you will probably find them in the bibliography of later papers that those same authors have cited. There is perhaps a certain kudos in such proxy citations, for it may be that the cited paper has achieved the equivalent of canonical status in the field.

Citation frequency is something of a lottery: language of publication; discipline (since 1953 Crick and Watson achieved three times Vine and Matthews's average citations); date of publication (E. Komatsu of the University of Texas at Austin has already had 1939 citations for his February 2011 paper 'Seven-Year Wilkinson Microwave Anisotropy Probe Observations: Cosmological Interpretations' published in a supplement to the *Astrophysical Journal*; nine times the rate of Crick and Watson, but the paper is about the origin of everything)

Interestingly, the December 2012 issue of *Geology* presents stats on the most cited papers that it has published since 2000 (Cowie, P.A. 2012. Highly cited *Geology* papers (2000-2010) – What were they and who wrote them? *Geology*, v. 40, p. 1147-1148). *Geology* is among the highest ranking journals in the geoscience field, and had an impact factor of 4.8 over the last 5 years. A journal's impact factor is the number of times all articles published in a 2-year period were cited in all indexed journals in the year following them, divided by the total number of articles published in the two years by the assessed journal. So, papers published in *Geology* between 2007 and 2011 were cited on average 4.8 times in the year following publication. This journal is a useful source of citation statistics as it covers the full range of geoscience and all papers are limited to 4 printed pages, thereby forcing authors to be concise and clear in their writing and illustration. Consequently it is popular, which, incidentally, may explain its high impact factor.

Of the 33 papers cited most between 2000 and 2010, 14 are on topics relating to Tibet and China. There are 3 on oceanography; 3 on paleontology and extinctions; 6 on palaeoclimatology; 10 on tectonics and 10 on magmatism (3 of which were about rare adakites formed by partial melting of subducted oceanic crust). I haven't read all of the papers, and the stats on topics may tell us very little, but I would bet that papers about geology in high-population emerging countries – China, India and Brazil – are met gleefully by rapidly growing communities of eager young geoscientists. It may even be worth a flutter on adakites as the 'next big thing' in petrogenesis. Mind you, it looks like I am not likely to be the best punter for hot papers, as out of the 33 'top-3' papers since 2000, only 6 made it into Earth Pages, and of those only one between 2004-2010.

The digest goes on to show that year-by-year as many as 10 % of papers in *Geology* are not cited at all, up to 70% are cited between 1 and 5 times per year, while less than 10% get 10 or more citations in a year. Oddly, the author suggests that a dip in citations of *Geology* papers in recent years may reflect the launch of *Nature Geoscience* in 2008. Yet glossy as that new addition to the *Nature* stable might be, it has become something of a desert for papers on geology. Then there is evidence for both 'vintage' and 'just-about-drinkable' years in *Geology* citations: the 'top ten' papers in 2001, 2005, 2006, 2008 and 2010 ranged from 10-15 citations for the tenth to 20-25 for the 'hottest' paper, while in 2000, 2002, 2003, 2004, 2007 and 2009 the most cited papers stood well above the rest at 32 to 55 citations per year. But that may just reflect the uneven pace at which well-received and provocative work emerges.

So, it begins to seem, from *Geology* at least, that for most geoscience authors publishing isn't going to raise much hope as far as jobs or promotions are concerned. Yet if results are not published funding agencies may become fractious about your next grant application, and of course, university science departments puff themselves with annual publication rates (though rarely citation records, which as far as geosciences goes could be a wise move). But it is a matter of academic duty to publish for the record; even if a paper fills just one tiny niche the cumulative effect of publically available knowledge does eventually result in breaks through – one never knows... It could be a salutary lesson should publishers release data on hits for on-line PDFs of papers, as that would give some indication of how many readers individual papers have, but as for a 'like this' button or a means of star rating I think we have to venture into the deeper recesses of academic conservatism one small step at a time.

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