



**QUEEN'S
UNIVERSITY
BELFAST**

Geological fakes and frauds

Ruffell, A., Majury, N., & Brooks, W. E. (2012). Geological fakes and frauds. *Earth-Science Reviews*, 111(1-2), 224–231. <https://doi.org/10.1016/j.earscirev.2011.12.001>

Published in:
Earth-Science Reviews

Document Version:
Peer reviewed version

Queen's University Belfast - Research Portal:
[Link to publication record in Queen's University Belfast Research Portal](#)

Publisher rights
Copyright © 2011 Elsevier B.V. This work is made available online in accordance with the publisher's policies. Please refer to any applicable terms of use of the publisher.

General rights
Copyright for the publications made accessible via the Queen's University Belfast Research Portal is retained by the author(s) and / or other copyright owners and it is a condition of accessing these publications that users recognise and abide by the legal requirements associated with these rights.

Take down policy
The Research Portal is Queen's institutional repository that provides access to Queen's research output. Every effort has been made to ensure that content in the Research Portal does not infringe any person's rights, or applicable UK laws. If you discover content in the Research Portal that you believe breaches copyright or violates any law, please contact openaccess@qub.ac.uk.

Open Access
This research has been made openly available by Queen's academics and its Open Research team. We would love to hear how access to this research benefits you. – Share your feedback with us: <http://go.qub.ac.uk/oa-feedback>

1 **Geological Fakes and Frauds**

2
3 Alastair Ruffell*¹, Niall Majury* William E. Brooks**

4 *School of Geography, Archaeology & Palaeoecology, Queens University
5 Belfast, N.Ireland, BT7 1NN, UK

6 **Geologist, Reston, Virginia

7
8 Received 25/4/2011, Accepted 23/11/11

9
10 **Abstract**

11 Some geological fakes and frauds are carried out solely for financial gain
12 (mining fraud), whereas others maybe have increasing aesthetic appeal (faked
13 fossils) or academic advancement (fabricated data) as their motive. All types of
14 geological fake or fraud can be ingenious and sophisticated, as demonstrated in
15 this article. Fake gems, faked fossils and mining fraud are common examples
16 where monetary profit is to blame: nonetheless these may impact both scientific
17 theory and the reputation of geologists and Earth scientists. The substitution or
18 fabrication of both physical and intellectual data also occurs for no direct
19 financial gain, such as career advancement or establishment of belief (e.g.
20 evolution vs. creationism). Knowledge of such fakes and frauds may assist in
21 spotting undetected geological crimes: application of geoforensic techniques
22 helps the scientific community to detect such activity, which ultimately
23 undermines scientific integrity.

24
25 *Keywords:* gems; fakes; frauds; mining; palaeontology; water

26 ¹Corresponding author

27 *E mail address:* a.ruffell@qub.ac.uk

29 **1. Introduction**

30 The faking of objects for financial gain and the fraudulent substitution of low value
31 objects for the valuable is common in the art world, antiques trade and mining
32 industry, amongst others. Many fakes and frauds use geological materials, or are
33 detected using methods common in the Earth Sciences. Fakes and frauds that have
34 no connection to the Earth sciences are not included in this review. The faking of
35 objects using geological materials is likely to have occurred before written
36 documentation, as Mesopotamian (c. 4,000 BC) creation of fake stones by heating
37 silt to a partial melt and cooling is recorded by Wilford (1998): this is essentially a
38 substitution case – replacing a high-value item with one of significantly less or no
39 value. Egyptian fakery using geological materials was well established by 300BC
40 (Gashe and Finch, 2008). In this case the fake was actually the earliest (1295 to 664
41 BC) recorded fake body part, a big toe made of linen, glue and importantly for this
42 review, the use of calcium sulphate hemihydrate plaster, created by heating gypsum:
43 again, essentially substitution. More contentious is the theory advanced by Joseph
44 Davidovits (Barsoum et al., 2006; Halford, 2006) that the bulk of the stones in the
45 Pyramids are reconstituted from sediment, clay and an early form of geopolymer, and
46 not of natural rock at all. The different value (relative or financial) of gems, crystals
47 and stones was known in prehistory as flint, obsidian and porcellanite were
48 selectively mined and traded. The first recorded instance of using mineralogical tests
49 to detect fraud was by Pliny the Elder (Healy, 1999). Pliny used a scratch test to
50 detect fake gems, knowing that diamond, the most valued gem at the time, scratched
51 all other minerals. All three of the above (historical) examples include elements of
52 what can still be seen in more recent fakes and frauds: substitution and fakery.
53 Financial gain is not proven in the above, unlike many of the cases outlined below:
54 the Mesopotamian stones may well have been faked for financial gain; the Egyptian
55 toe was undoubtedly for aesthetic purposes; the Pyramids (if correct) would have
56 been made of constructed stone for labour-saving (cf. financial) reasons. Thus, even
57 2,000 to 4,000 years ago there were geological fakes being perpetrated for financial
58 and aesthetic reasons. Recently, a third reason for carrying out geological fakes and
59 frauds has emerged: those crimes that combine the financial with the aesthetic (e.g.
60 faked fossils that are scientifically important but also carry a high price). This review
61 examines the types of geological fake and fraud that have occurred, giving some
62 examples that serve to inform Earth scientists of the possibility that data, fossils,

63 gems, ores and even oil, may all be fabricated for financial gain, personal self-
64 promotion, or a mix of the two. The published facts and personal communications for
65 the cases are described, followed in each section by some conjecture on the
66 probable or possible motives for the fake or fraud. Methods for detecting fakes and
67 frauds are briefly mentioned. For a comprehensive guide on the detection of fakes
68 and frauds, the reader is directed to Craddock (2009). A healthy cynicism concerning
69 what appears to be geologically fantastic may help prevent future criminal activity
70 that in the past has brought many of the geosciences into disrepute.

71

72 **2. Economic Fakes and Fraud**

73 2.1 Substitution

74 The famous zoologist and correspondent of Humboldt and Darwin, Professor
75 Christian Gottfried Ehrenberg carried out a classic investigation of substituted
76 materials. This was described in Scientific American (1856, p.240) '... on one of the
77 Prussian railroads, a barrel which should have contained silver coin, was found, on
78 arrival at its destination, to have been emptied of its precious contents, and refilled
79 with sand. On being consulted on the subject, he (Ehrenberg) sent for samples of
80 sand from all the stations along the different lines of railway and by means of his
81 microscope, identified the station from which the interpolated sand must have been
82 taken. The station once fixed upon, it was not difficult to hit upon the culprit in the
83 small number of employees on duty there.' Substitution continues to this day as a
84 common criminal practice, often using geological materials (due to their weight, size
85 and zero cost) as replacement materials. Murray (2004) provides examples that
86 include whisky bottles in boxes being exported by ship from Scotland, and on arrival
87 at their final destination, the bottles had been replaced by granite cobbles. The ship
88 had docked at a number of ports in different countries *en route*: the granite was a
89 distinctive type that was only found in one of the countries. A visit to the port
90 established a pile of similar cobbles in a yard close to where the ship had been
91 moored. The dock workers who had access to both the dock and ship were
92 questioned and the guilty parties admitted their crime: however, the whisky was not
93 recovered. In a modern twist to such substitution, Ruffell and McKinley (2008) record
94 the delivery of high-value experimental computer drives from the Far East to northern
95 Europe, with the cargo plane stopping once in the Middle East and once in the
96 Mediterranean. On arrival, the packages were found to contain brick, rocks and some

97 bags of soil. The combined approach of a geological and palynological assessment,
98 showed the pollen and soil types to be typically Mediterranean, excluding the Far
99 Eastern source, northern European destination, and Middle Eastern stop-over. An
100 enquiry at the Mediterranean location led to the identification of a suspect, who lost
101 his job but criminal proceedings were dropped.

102

103 2.2 Gems, Precious and Semi-precious Stones

104 The basics of gem fraud are straightforward, with the Mesopotamian example given
105 at the start of this review as an example of what still occurs today – the creation of
106 fake valuable gems and stones using cheap or valueless materials. Murray (2004)
107 gives examples of modern methods of gem fraud and these are summarised by
108 Matlins and Bonanno (2009). These include treating diamonds with high-pressure,
109 high temperature methods that remove coloured impurities, leaving the more
110 valuable colourless variety. The opposite is true, with colours being added to
111 otherwise dull stones, or flaws being concealed in an otherwise real gemstone.
112 Diamond, ruby, emerald and sapphire are now all synthesised by sophisticated
113 means: Matlins and Bonanno (2009) explain how these synthetic gems can only be
114 recognised by highly skilled gemmologists. However, as Boles (2008) explains, the
115 scientific aspects to gem or precious stone fakery are sometimes the result of the
116 work of a large network of criminal or terrorist activity. Such individuals control both
117 the creation and sale of such items as fake diamonds and emeralds, or the
118 substitution of illegally-mined real gems (such as ‘blood diamonds’ in Africa) for those
119 claimed to be from licensed mines. Intense scrutiny from NGOs (non-governmental
120 organisations) and the media, coupled with growing consumer anxiety has, in recent
121 years, encouraged ~~in recent years~~ the development of traceability systems to track
122 and certify the origins of precious and semi-precious stones through initiatives such
123 as the Kimberley Process (Bieri 2010). This serves to illustrate that interweaved
124 among the aesthetic and pecuniary aspects of gem fraud are also moral anxieties
125 associated with corruption, conflict and resource extraction in developing countries
126 (Maconachie and Binns 2007).
127 There is an aesthetic aspect to gem fraud, although this is secondary to financial
128 gain.

129

130 2.3 Mining

131 Whilst not providing the earliest of geological frauds, mining is associated with the
132 greatest financial gain of all our fakes and frauds, and in the case of the Bre-X scam
133 (Coffee, 2001; Tsing, 2000) one of the few associated with a possible murder. As
134 Naylor (1997) suggests that mining ventures are susceptible to fraud for a number of
135 reasons, including: heightened material gain, the financial return; the material gain
136 (property), mythological and religious appeal of precious metal or because and the
137 low concentrations of ore that indicate that a once financially-promising
138 prospective venture may be no longer viable. possible. The latter may lead to
139 the 'salting' of core, sediment or spoil heaps, deceiving yet an acceptance by
140 investors when no significant ore has been found. He notes that the complex
141 geology of ore-bearing successions and the ever-changing methods of assaying
142 make it difficult for the geologist to detect fraud. Handling the indeterminacy of
143 mineral claims has posed a perennial problem for financial regulators, charged with
144 reconciling the need for efficient mechanisms to raise capital for new ventures and a
145 requirement to protect the investing public from fraud. In Canada, for example, the
146 legal framework that governs securities markets at large, evolved principally in step
147 with a series of mining scandals that undermined public confidence in the claims of
148 prospectors, junior mining firms and the banking community (Condon 1998, Majury
149 2007). The Windfall Oils and Mines (1964) and Bre-X (1997) scandals led,
150 respectively, to the creation of a system of continuous disclosure of information for
151 publically listed companies and, more recently, rules that set out the format of
152 technical reports on exploration or estimation work, the professional profile of who
153 can produce these reports and where legal liability resides (Dagbert 2005). Mining
154 scandals have played a significant role in formally shaping many of the norms and
155 legal requirements that Earth scientists today take for granted as part and parcel of
156 professional practice. The fraudulent practice method of placing ore in a location or
157 drill-core, selling the land and vanishing is well known (Abbot, 2005), leading to a
158 large number of cases, two classic examples (one historic and one more recent) of
159 which are outlined below.

160

161 2.3.1 Abbot's Dirt Piles

162 Abbot (2005, p.30) describes a classic case of mining fraud, wherein 'A number of
163 the cases I investigated are known as "dirt pile" cases... whereby ... ' investors buy a
164 specific very small volume (a few tons or cubic yards) of ground or a specified pile of

165 "ore" that is guaranteed to contain a specified amount of gold and other precious
166 metals. Because the investor "owns" his dirt pile, he could come to the site and mine
167 and process it, or he can hire a supposedly independent contractor to do the mining
168 and processing to recover the precious metals. Investors invariably take the latter
169 option. ... in Swandyke, Colorado, the piles of dirt were composed of the tailings —
170 rock deemed useless by the miners'. Because the tailings did not actually contain
171 valuable minerals in quantities large enough to be economic, the promoters in this
172 case salted the surface of the piles with fool's gold, or pyrite-rich, samples that are an
173 indicator of possible gold content. His (Abbot, 2005) description is a classic case of
174 geological fraud – the placing of minerals in order to increase the value of worthless
175 land or material be it dirt piles, ore, gems or fossils (see below).

176

177 2.3.2 The Bre-X Scam (Fraud)

178 This is probably the best-known mining fraud ever perpetrated. Web-based reports
179 and views on the scandal are common, along with published books (Goold and Willis,
180 1997; Hutchinson, 1998; Whyte and Danielson, 1997). Mining companies rarely find
181 precious metal ores before leasing land for prospecting. More commonly, there is
182 speculative information that the land may contain ore, and it is up to the company to
183 establish what is there. Thus it was when the Canadian company Bre-X Minerals Ltd.
184 bought the rights to a site near the Busang River (Borneo) in 1993. A drilling program
185 and geological evaluation (March 1997) indicated that a huge gold deposit was likely
186 ~~to occur~~ in the region. This information reached the stock markets and takeover offers
187 began, with confirmatory test drilling being carried out to verify the results. Four
188 weeks later, Bre-X's geologist at Busang, Michael de Guzman, fell from a helicopter,
189 just as the test results proved insignificant amounts of gold. The next day Bre-X stock
190 lost almost all of its value. Upon microscopic examination by an independent
191 geologist, it was found that the supposedly hydrothermal gold fragments were
192 rounded, as is common in placer deposits. There have been other claims of gold
193 being shaved from jewellery to 'salt' the sample. The former seems most likely
194 (Goold and Willis, 1997; Hutchinson, 1998). The fraud involved placing gold from one
195 source (unknown, but some definitely from a placer deposit) into another (a
196 hydrothermal vein system), something that should have been spotted by a trained
197 geologist, except in this case it may well have been geologists who carried out the
198 fraud. In order to confuse the differentiation of placer vs. hydrothermal gold,

199 anecdotal evidence shows fraudsters rolling gold leaf into cigarettes. The ash,
200 including melted gold, is covertly tapped in the drill hole, creating neat spherules of
201 gold in the cuttings (G.Earls, pers. Comm, 2010).

202

203 2.4 Water and Groundwater

204 The Alabama Cooperative Extension System (Alabama AandM and Auburn
205 universities: <http://www.aces.edu/>) summarise the large number of fake and frauds
206 involving water. This site shows how the mysterious nature of water, as a universal
207 solvent and life-supporting medium, together with its easily altered property, can
208 make it vulnerable to criminal activity. Early examples include the use of water-based
209 cures for illness promoted by quack doctors, such as drinking radium-enriched water
210 in the 19th Century and including some aspects of the present-day bottled water
211 industry (Mather, 2004). These include oxygenation, ionisation, magnetising,
212 fluoridation and filtering of either natural or tap water in order to remove chemicals
213 like chlorine and impart some measurable property to the water that can be sold as
214 health-giving. Associated water scams include those who claim to have the ability to
215 find groundwater by dowsing, rain-dances, cloud seeding and bogus drilling
216 operations. Some supposed scams have turned out to be true: the therapeutic nature
217 of some spa waters is likely due to their temperature not mineral content;
218 therapeutic water treatments do work and many drilling operations do indeed find
219 water (Mather, 2004). Therein lies the problem with water scams that besets all
220 geological fakes and frauds: the mixing of truth with fabricated material or data, such
221 that each becomes hardimpossible to disentangle.

222

223 2.5 Oil and Gas

224 Like any industry with high economic returns, the oil and gas industry has been and
225 is still susceptible to fraudulent activity, from bribery (Andvig, 1995), from the over-
226 estimation of reserves prior to acreage sale (Andvig, 1995), or the faking of oil finds
227 when none exist (Ruffell and McKinley, 2008). The latter case is more 'scientific' than
228 cases of bribery, wherein a geologist looking for investment in exploration of an area
229 (and thus maintain his employment) returned from China with oil-bearing core, taken
230 from a drilling operation. Examination of the oil patches in sandstone core indicated
231 that the oil had been injected, using finely drilled holes and a syringe of oil from
232 another location.

233

234 **3. Aesthetic and Academic Fakes and Frauds**

235 3.1. Background

236 Included in this group are the kinds of fakes or fraudulent activity that are not
237 perpetrated primarily for financial gain. Money often is behind such activities, such as
238 selling of spectacular faked fossils, minerals and meteorites or career advancement,
239 yet the primary activity is not simply financial trickery, as in the above economically
240 driven crimes. Rather, these types of controversies are primarily associated with
241 aesthetic values, beliefs, scientific controversies, social status and the adjudication of
242 claims to knowledge (Livingstone 2003).

243

244 3.2. Palaeontology

245 Along with the Bre-X mining scandal, fossils have been among the most famous of
246 geological fakes and frauds, from Cuvier's accusations of Mary Anning's plesiosaur
247 to be a fake, to the Piltdown Man, substituted trilobites, Baugh's faked human
248 footprints, Gupta and Imam's (Granier et al., 2009) removed fossils and modern
249 insects in amber ([Ross, 2004], wherein Victorian fakers drilled holes in amber,
250 inserted modern insects and sealed the holes again). A search of the Internet reveals
251 that faked fossil fish, shrimps/lobsters and dinosaurs are extremely abundant and
252 can be purchased on the open market. Martill (1994) and Forey (2004) both show
253 how the fakers of fossil fishes make their creations primarily for financial gain,
254 however this although this is also an expressive aesthetic activity, shaped by the
255 imagination of the artisan and what he or she anticipates will find a market often
256 for crosses over into the aesthetic. UHowever, unlike fossil substitutions, few have
257 ever been created in order to directly influence scientific thought. This said, many
258 have been used to influence the thoughts of Creationists and the circulation of some
259 fake fossils has produced unintended consequences. For example, the use of frog
260 skeletons in Some faked fossil fishes was that use frog skeletons in their have
261 nevertheless inadvertently y been used in discussions regarding the origins of
262 tetrapods, albeit that the fakers did not have this intention (Forey, 2004).

263

264 3.2.1 Beringer Tricked

265 Among the first recorded palaeontological fakes, were those carried out by Ignatz
266 Roderick and Johann Georg Eckhart in 1725. They wished to deceive their colleague

267 at the University of Wurzburg, one Johann Bartholomeus Adam Beringer (Pain,
 268 2004). Angered by their colleague's arrogance, Roderick and Eckhart carved the
 269 images of frogs, lizards and spiders into pieces of limestone, along with Hebrew
 270 religious names, and planted them in places Beringer would go collecting fossils.
 271 Beringer found the planted fakes and took them seriously, publishing a monograph,
 272 the *Lithographiæ Wirceburgensis* in 1726. Although critics pointed out chisel marks in
 273 some imprints, ~~which~~ Beringer believed these to be proof of the hand of God in
 274 making fossils. Roderick and Eckhart became concerned at how serious their joke
 275 had become, and tried to persuade Beringer that the specimens were fake. Instead
 276 of believing them, he became angry and took the two to court, where the truth was
 277 discovered: the incident ruined the reputations of all three, with Beringer discredited
 278 as a scientist, Roderick forced to leave Wurzburg and Eckhart lost all his University
 279 privileges. This ~~is a true aesthetic/academic~~ fraud, with no financial gain intended on
 280 the side of the tricksters, was motivated by professional rivalries (who were Roderick
 281 and Eckhart); some doubt could also be cast on Beringer, whose career ambitions, it
 282 might appear, led him to be so easily tricked. However, Mallott (1982) has pointed
 283 out how the forgeries themselves in fact reflected 16th ideas on the nature of fossils.
 284 Roderick's sculpted stones' depictions of heavenly bodies, human art (writing),
 285 animals and plants reflected a hierarchical view of the universe with God at the
 286 centre (Renaissance Neoplatonism) and the associated belief that fossils grew
 287 within the Earth, taking form from the stone itself. Roderick, in trying to deceive his
 288 colleague, took a 16th century concept of fossils and literally transformed it into stone.
 289 This presented Beringer, Mallot argues, with a conundrum: how to make sense of
 290 'the fossils' in terms of the contemporary mechanistic (Newtonian) views of nature
 291 that had come to prevail by 1725. It is not surprising that Beringer found the stones
 292 confusing and contradictory, for they embodied a concept of the nature of fossils that
 293 no longer made sense. In the conclusion of his book (p.159) he even admitted that
 294 his interpretation of their meaning was 'one of piety and expediency rather than of
 295 erudition and the science of physiology'. For Beringer, Roderick and Eckhart, the
 296 hoax exposed what were construed within the scientific community as vulgar degrees
 297 of ambition and professional jealousy, challenging the notion of the gentlemanly
 298 pursuit of truth, ruining their reputations and careers.

Formatted: Superscript

Formatted: Superscript

301 3.2.2 Cuvier's accusations of Mary Annings Plesiosaur

302 Mary Anning was a self-educated fossil collector who lived and worked in Lyme
303 Regis (Dorset, England) through the early 1800s. She had a remarkable gift for
304 finding and preparing fossils, and soon became key to many of the scientific
305 acquisitions made by museums and universities in Oxford and London as well as
306 throughout Europe (Germany and France especially) and in the USA. We have to
307 view her work against a backdrop of [a scientific community](#) society_ dominated by men
308 (the Geological Society of London did not allow female fellows) [of financial](#)
309 [independence whose conscious cultivation of social position and associated codes of](#)
310 [gentlemanly conduct were believed to be a source of objectivity, setting them apart](#)
311 [from others who may need to fabricate materials for material advantage \(Shapin](#)
312 [1996\), and within that, beset by scientific rivalry \(Torrens, 1998\)](#). On 10th December,
313 1823, her discovery of a series of superb fossils of the dolphin-like marine reptile
314 *Ichthyosaurus* was overtaken by the first ever specimen of a long-necked, four-
315 flippered *Plesiosaurus* recovered outside of Germany. This caused Cuvier, the
316 famous Parisian palaeontologist, to accuse Anning of faking the fossil. Examination
317 by other experts proved Cuvier wrong (Torrens, 1998), establishing Anning's
318 credibility and probably enhancing her career. The origin for Cuvier's suspicions are
319 unknown: Anning obviously had the time, tenacity and gift for finding important
320 fossils, which may have caused a feeling of jealousy, especially for a woman_in an
321 age of male dominance. Conversely, Anning was obviously from a poor background,
322 for whom the financial gain from these fossils would be highly motivating. [As she](#)
323 [depended on her fossil collecting for economic survival, her word was not to be](#)
324 [trusted by natural philosophers such as Cuvier, who drew upon the genteel](#)
325 [resources of social privilege to conduct science. Anning was very much an outsider,](#)
326 [whose discoveries challenged the not just the significance of other's finds, but also](#)
327 [received notions of the ways in which science should be practiced and by whom.](#)

328
329

330 3.2.3. Deprat and the Substituted Trilobites

331 Osborne (2000) provides a very comprehensive account of the life of Georges
332 Deprat, French-Indonesian geologist, his colleagues and eventual adversaries
333 (Lacroix and Mansuy), the lives they led as colonial explorers and the eventual
334 enquiry into possibly substituted trilobites. The discovery of these fossils, with

335 similarities to European forms, implied either a marine link between Europe and the
336 Far East in the Lower Palaeozoic, or the planting of the specimens in French Indo-
337 China. The enquiry that took place before, during and after the First World War,
338 explains some of the confusion created. Osborne concludes, much as we have done
339 for Mary Anning and the Piltdown Man (see below), that the lack of a resolution in the
340 case was more to do with the social structure at the time than the reality of the fake
341 or who carried it out. The origin of the fossils remains suspect; the perpetrator has
342 still to be ascertained. Henry (1994) and Durand-Delga (1990) are convinced Deprat
343 was guilty, although the former casts doubt on the latter's methods of establishing
344 this. If Deprat or Mansuy placed the fossils in the suspect location, or claimed they
345 came from this place, they did this primarily to prove a scientific theory. However,
346 proving this had benefits for Deprat's career especially, with attendant fame and
347 financial gain.

348

349 3.2.4. Gupta – Possibly the Greatest Palaeontological Fraudster

350 The incredible story of fossil substitution by V.J. Gupta unravelled as a number of
351 scientists raised concerns about Gupta's work, which included a Masters thesis, 455
352 papers (many co-authored with very prestigious scientists), five books and two 1964
353 papers in *Nature*. In 1978 Gilbert Clapper (Chicago) visited a colleague, Villi Zeigler
354 (Marburg) to discuss Devonian conodonts: whilst in Germany, Clapper met a visiting
355 Australian academic, John Pickett, who, with his colleague John Talent, had visited a
356 road-cut in Himalayan Nepal that V.J. Gupta of Panjab University described as
357 yielding prolific numbers of Devonian conodonts. The pair failed to find any fossils in
358 any but one of the twenty sites they sampled. This one sample location produced
359 conodonts of Silurian age. Clapper and Pickett then noticed the same photograph in
360 two works by Gupta, describing faunas from locations some 600km apart: this could
361 be accounted for by a simple error of adding the wrong photograph. However, when
362 Clapper, Pickett and Ziegler examined Gupta's papers, and especially the illustrated
363 fossils, they were struck by the similarity between the Himalayan fauna and that
364 collected from Buffalo (New York) by George Hinde in 1879. It took another nine
365 years for the real problems Gupta had created to be made public. At a specialist
366 meeting on the Devonian System (Calgary 1987), Gupta was invited to comment on
367 why data from India should not be included in a palaeobiogeographic reconstruction,
368 leading to him demanding details of why the question had been raised in the first

369 place. The committee responded by sending the details to Gupta's Vice-Chancellor:
370 not long afterwards Talent (1989) and Lewin (1989) published articles in *Nature* and
371 *Science* that unveiled the whole story, including Gupta's theft of fossils from
372 colleagues and collections around the world, but especially the Hinde Collection, and
373 then claiming the specimens were from India. Gupta attempted a rebuff in *Nature* that
374 only further dammed him: he remains the most notorious known fossils fraudster who
375 committed crimes for personal academic gain.

376

377 3.2.5. Baugh's faked human footprints

378 Carl Baugh is as notorious as Gupta, although his motivations appear to have been
379 very different. Baugh is a Young Earth Creationist whose greatest fake was to claim
380 there were human footprints alongside those of dinosaurs in the Cretaceous strata of
381 the Paluxy River (Texas, USA). Baugh's motivation appears to have come from the
382 site's previous owners, one of whom later admitted to carving some of the tracks.
383 Heinrich (1996) has (without bias) gathered the main literature concerning the tracks,
384 with over 100 published works. Baugh's credentials have been questioned by Kuban
385 (1989, p.62); the 'man tracks' have been proven either non-existent or of different
386 origin by Cole et al (1985). The Wikipedia entry for Baugh makes fascinating reading,
387 including his claims of discovering an 18th Century Miner's hammer in Ordovician
388 strata, his dealings with convicted criminals (one of whom sold him a supposed
389 dinosaur – human footprint) and claims of earning numerous degrees, mostly from
390 private universities. Perhaps what is most interesting about Baugh is the fact many
391 creationists consider his activities counter-productive to their cause. Baugh's
392 motivation is almost entirely for reasons of belief, although he runs an exhibition and
393 gives lectures for the publicity and presumably makes some financial gain from his
394 activities.

395

396 3.2.6. Modern Insects in Amber

397 Amber itself is often faked, both as a jewellery item and for the scientific study of
398 included fossil plants and insects, along with other animals that get trapped in the
399 fossilised tree resin. Glass, resin and plastics are commonly used (Ross, 2004) to
400 create faked amber and its inclusions. However, a more serious fake was uncovered
401 by the Natural History Museum in London in 2003 (Grimaldi et al., 2010) where
402 workers showed how Victorian fakers had drilled into real Baltic amber, inserted a

403 modern insect (now named the Piltown Fly), melted the drilled amber and poured
 404 this into the hole, annealing the surface in the process. The existence of modern
 405 insects in Palaeogene and Neogene amber caused problems for evolutionary
 406 biologists for many years until the fake was discovered by careful microscopic
 407 examination. The origin of such fakes is both aesthetic (the amber being worn as
 408 jewellery) and economic (much like the more common faked fossils), the amber
 409 being worth more with insects in it than without.

410

411 3.2.7. Faked Feathered Dinosaur

412 The first *Archaeopteryx* was found in Solnhofen (Bavaria, Germany) in 1861 and was
 413 soon accepted as key evidence of birds and reptiles sharing common ancestry
 414 (Huxley, 1864). Yet *Archaeopteryx* is essentially an early bird with dinosaur-like
 415 features: it has teeth and a long-bony tail (theropod dinosaur characteristics)
 416 alongside feathers, a mobile wrist and a lightweight skeleton (bird-like
 417 characteristics). For many years, until 1999, despite the discovery of a number of
 418 small-bodied theropod dinosaurs with feathers of various types, an exact
 419 'intermediate' between non-avian theropods and birds remained elusive in the fossil
 420 record. Indeed, the unique nature of *Archaeopteryx* led Hoyle et al (1985) to claim
 421 the two best-known specimens were fakes. This suggestion was clearly destroyed by
 422 Charig et al. (1986). ~~A very clear account of the debate is given by Chris Nedin~~
 423 ~~(<http://www.skepticfiles.org/origins/archaeo1.htm>), whose unbiased view lets the reader~~
 424 ~~know~~The critical point here is that Hoyle et al. (1985) are not palaeontologists, where
 425 Charig et al. (1986) are. When the fossil named *Archaeoraptor liaoningensis* from
 426 Liaoning in China was 'discovered' in 1999, it appeared to neatly complete the
 427 succession between dinosaurs (reptile) – feathered dinosaur – and birds. The fossil
 428 was 'collected' in China and found its way to the United States, into the hands of
 429 dinosaur artist Stephen Czerkas, (<http://www.dinosaur-museum.org/>) who
 430 collaborated with ~~a journalist from~~ National Geographic Magazine, where the name
 431 *Archaeoraptor liaoningensis* first appeared. Both the apparently transitional nature of
 432 *Archaeoraptor* and the process of it being named outside the peer-reviewed scientific
 433 literature caused ~~great controversy~~a fire storm amongst in vertebrate
 434 ~~palaeontologists~~ (see: <http://www.answersingenesis.org/docs/4159.asp>). It seems
 435 that a number of leading vertebrate palaeontologists were taken in by the
 436 *Archaeoraptor* specimen: it has been claimed that several leading experts had

437 verified the authenticity of the fossil to Czerkas before he went public, but
438 subsequent CT scanning work showed the specimen to comprise the remains of at
439 least three individual animals, including one Cretaceous bird and one non-avian
440 theropod. The fake was likely perpetrated by a local fossil hunter/dealer in order to
441 create a scientifically unique and valuable specimen: their fake had major scientific
442 implications until discovered.

443

444 **4. Archaeological and Historical Fakes and Frauds**

445 4.1. Introduction

446 Archaeological fakes are as abundant as those that are strictly geological. Another
447 review article could be written on this subject, so just the notorious and those that
448 have been revealed using geological methods are included here. Notorious
449 archaeological fakes that have not been investigated using geological methods may
450 also be of interest to the reader ~~_, and an examination of the website~~
451 ~~www.archaeology.org/online/features/hoaxes/index.html (and includes Fawcett's~~
452 ~~Figurine; the Hercules Sarcophagus; the Metropolitan Museum of Modern Art's fake~~
453 ~~Etruscan Warriors and the faked Praeneste Fibula) will provide further, non-~~
454 ~~geological, details.~~

455

456 4.2 Piltdown Man

457 *Eoanthropus dawsoni*, or Piltdown man, was brought to the attention of the scientific
458 community by Charles Dawson, a fossil collector, who claimed a human skull had
459 been found by workman in a gravel pit at Piltdown in Sussex in 1912. It is the
460 supposed location of the find, a gravel pit, that gives the case a geological aspect.
461 Dawson took the skull to Arthur Smith Woodward (then Curator of the British
462 Museum). Together, they revisited the pit and found further skull fragments and a
463 jawbone. For 40 years Piltdown man, with his huge, humanlike braincase and apelike
464 jaw, remained on display in what is now the Natural History Museum in London as an
465 example of the notorious "missing link" between humanity and its primate ancestors.
466 On November 21, 1953, however, an article in the Times newspaper (by Kenneth
467 Page Oakley, Sir Wilfrid Edward Le Gros Clark and Joseph Weiner) pronounced it a
468 crude forgery, the marriage of a modern human skull and an orangutan's jaw, and
469 decided that the entire package of fossil fragments at Piltdown - which included a
470 ludicrous prehistoric cricket bat (a carved elephant bone)- had been planted by
471 someone. Whilst the fossil is undoubtedly the faked combination of a Medieval

472 human skull with an orangutan's jaw, the identity of the perpetrator is still a mystery.
473 Top of the list of suspects is Dawson, with Sir Arthur Woodward (British Museum
474 curator at the time) in second place. Sir Arthur Conan Doyle (who lived 10km from
475 the discovery site) has also been implicated, although this seems unlikely as he had
476 no motive to commit such a fake and the chances of discovery by a workman would
477 be slim. However, as both Boylan (2004) and Brook (2004) point out, there is much
478 more to the Piltdown Man than who committed the fake: both show how the
479 technology to discover the fake had been available at the time of its discovery, yet
480 was not used to question the find. The implication is that some sections of society
481 wanted a so-called 'missing link' between apes and humans to be discovered, in
482 order to validate an evolutionary theory. What is even more incredible is that this was
483 not the first time human remains had been planted in order to prove a scientific
484 theory: in 1866 Josiah Whitney of the California State Geological Survey
485 (Archaeology, 2010) reported the discovery of a skull that had been found in a
486 mineshaft at about 90m depth, in layers containing alluvial gold, below a volcanic
487 succession. The ~~overlying volcanic rocks were known to be of some considerable~~
488 ~~age, and thus the~~ find was reported as the oldest known human remains from the
489 North American continent. The skull was identical to those excavated from nearby
490 Native American graveyards: in addition it had a cobweb inside, proving its faked
491 provenance. Creationist thinkers have nonetheless used the discovery of the skull as
492 evidence of humans existing on Earth long before scientific observations suggest.
493 Little financial gain was afforded by this or the Piltdown affair, bar career
494 advancement and intentional or otherwise promotion of a particular belief or scientific
495 theory.
496

497 4.3 Saitapherne's Golden Tiara – a Tale of Weathering

498 In 1895, newspapers throughout Europe were reporting the discovery (by peasants)
499 of a buried solid gold tiara that bore inscriptions indicating it was a gift from Olbia, a
500 former Greek colony on the Black Sea coast (now near Odessa, in the Ukraine), to
501 the 3rd-century B.C. Scythian king Saitaphernes. The inscriptions were identical to
502 those already known from Scythian objects from the area, something the purchasers
503 (the Louvre Museum in Paris) should have noticed as oddly coincidental. It was the
504 lack of weathering that raised most suspicions about the object: the object was nearly
505 perfect with no blemishes such as an expert in weathering might expect from over
506 2,300 years of burial, nor any dents or scratches such as an archaeologist may
507 observe on similar-aged objects. It was this remarkable state of preservation that led
508 to the Louvre purchasing the tiara yet the absence of such weathering or marks that
509 should have also aroused suspicion. Although an object of great academic and

510 aesthetic interest, the motivation for perpetrating this fake was obviously financial,
511 making this a mixed-origin crime.

512

513 4.4 Bosnian Pyramids and Glacial Geomorphology

514 In 2006, news emerged of ancient pyramid-like structures being discovered in Bosnia
515 by an archaeologist called Semir Osmanagic. Osmanagic claimed that new
516 excavations of the structures were required as preliminary dating suggested an age
517 of 12,000 years BC. Subsequent to his request for funds and this news, two things
518 emerged about the structures and Osmanagic. The structures, pyramidal-shaped
519 mountains, were purported to be made by humans 12,000 years ago, when this
520 mountainous area of Bosnia was subject to the harsh conditions of the end of the last
521 glaciation: the few humans that may have ventured near ~~the area~~ would have been
522 Palaeolithic hunters, hardly capable of constructing pyramid-shaped structures out of
523 natural rock (Rose, 2006). The mountains are obviously natural mountains. On
524 Osmanagic, it emerged that he claimed the mountain to be one of five pyramids in
525 the area. He linked the structures to similar features found north of Mexico City, on
526 the Moon ~~and~~ on imaginary planets (one called Dragon). It is only on reading
527 Osmanagic's book *The World of the Maya* (Gorgias Press, Euphrates imprint, 2005)
528 that we discover he believes the Maya and others are descended from Atlanteans
529 who came from the Pleiades star constellation. What Rose (2006) points out is how
530 the original story of the Bosnian Pyramids was accepted by many popular scientific
531 journals at the time, without question. There is limited financial motivation for
532 Osmanagic's proposition for the origin of the mountains: more likely are either career
533 motivation or a spiritual belief that is incompatible with mainstream science.

534

535 5. Art Fraud

536 Two reasons exist for the geoscientist to be involved in investigations into art fraud:
537 methods of investigation and the materials used. Methods include the truly
538 geoscientific such as the microstratigraphy of paint layers, dendrochronology and
539 mineral identification, to those in which geoscience methods play an important role in
540 interpretation (SEM EDX, XRD, FTIR). Murray (2004) considers Walter C. McCrone
541 to be a pioneer in both applications, with perhaps his most famous work on the
542 pigments in the Turin Shroud (including ochre and hematite) confirming radiocarbon

543 dates of a 14th Century origin. He famously suggested the Vinland Map (which, if
544 proven to be genuine, would indicate that most of Greenland and northern North
545 America were known in 1440) to be a fake (McCrone and McCrone, 1974), by a
546 number of means including the titanium oxide-based pigments used not being known
547 until 1917: the origin of the map remains controversial. A classic case of using paint-
548 layer microstratigraphy to establish art fraud may be found in Wieseman (2010). 'A
549 Man with Dead Birds' by the 17th Century Delft painter Pieter de Hooch had been
550 suggested to be a collaborative work between de Hooch and another artist Jan
551 Baptist Weenix. This idea was rejected, leaving stylistic discrepancies in the painting,
552 even though the human figures appeared to be by de Hooch, with questions raised
553 about the background and the dead bird in the foreground of the work. A thin section
554 of the blue paint showed lead-antimony (Naples Yellow) with ultramarine, and red
555 earth. The former was in use in the early 18th and later 19th centuries – suggesting an
556 overpaint. Areas with no suspected overpaint revealed lead-tin yellow, consistent
557 with 17th century painters. The work had been altered in order to increase its value:
558 Wieseman (2010) alludes to the culprit being the Antwerp painter Ignatius Van
559 Regemorter, a notorious Dutch art dealer and copyist. Like many of the subjects
560 included in this review, a separate paper could be written on art fraud, from the
561 mineralogy of marble forgeries (Polikreti, 2007) to mineral content in faked art using
562 Raman microscopy (Clark, 2006) and using isotopes to test the provenance of
563 carved materials such as bone and ivory (Stos-Gale, 1992). Art frauds fall into the
564 same bracket as many fossil frauds: perpetrated for financial gain but with major
565 [scientific \(and in this case, historic\) repercussions for our understanding of the history](#)
566 [of art.](#)

568 **6. Reasons for Committing Geological Aesthetic or Academic Fakes and** 569 **Frauds**

570 The reasons for committing fakes or creating frauds for financial gain do not warrant
571 further discussion than that provided above: the methods by which such activity
572 occur are the most interesting and ingenious. More complex are the reasons for
573 carrying out such activities for no sole financial gain. Goodstein (2010) suggests that
574 there are five main reasons for academics and non-economic geologists to fake or
575 fabricate data. These are: career pressure (the publish or perish syndrome); laziness;
576 the ability to get away with it (the power trip that goes with hoodwinking peers or

577 senior colleagues); financial gain and ideology. Career pressure could be cited in the
578 case of Deprat (if he carried out the fraud). The same goes for Gupta, to whom
579 laziness in collecting could be added, but certainly not in output or effort! Suspicions
580 of financial gain were certainly behind Cuvier's accusation of Mary Anning. Most
581 modern archaeological (stone tools, pottery, carvings, precious objects such as
582 Satapherne's Golden Tiara) and fossil fakes (frogs, fish, lobsters) are created for this
583 purpose, with the Chinese feathered dinosaurs being similar to the Piltdown Fly –
584 created for one purpose (financial, aesthetic respectively) yet resulting in major
585 scientific debate. Ideology is certainly the driver behind Baugh's faked fossil
586 footprints (and other creations), Osmanagic's pyramids and the Piltdown Man.
587 However, the Piltdown Fly was probably not created with the intention of confusing
588 evolutionary biologists studying fossil insects, rather it owed its origins to aesthetic
589 sensibilities and commercial interests, yet it had this unintended consequence result.
590 The Creationist – Evolutionist debate would certainly fall into the latter category, with
591 a plethora of websites dedicated to both camps, with accusations of fakery in each
592 (see the descriptions of Baugh's human and dinosaur footprints, above). To
593 Goodstein's (2010) five categories, Ritchie (1998) notes how some frauds or hoaxes
594 illustrate a wider tension within science between reconciling personal belief or
595 commitments with prevailing scientific orthodoxy (Polkinghorne 1998), implies a third
596 – someone who has a belief or faith yet can publish articles from the opposite view.
597 He illustrates this with evidence is based on of the remarkable situation concerning
598 Dr Andrew Snelling, who publishes widely from a Young Earth Creationist
599 perspective, but is also a consulting geologist on uranium mineralisation, with neither
600 'author' acknowledging the other. Ritchie's account of Snelling does suggest some
601 denial of what Snelling believes to be true: Snelling himself is rational about the
602 situation, stating that he publishes scientific articles based on consensus knowledge
603 (e.g. the dating of rocks) and publishes creationist articles from what he believes.
604 However, as Latour (2004) noted with regards evidence on climate change, when
605 capitalised upon by reactionary interests, the rapid circulation of fakery, accusations
606 of fakery and counter critique within the electronic media can quickly reshape matters
607 of concern as matters of 'fact', with serious implications for the reputation of the Earth
608 Sciences and their role in informing public policy.

609
610

611 **7. Conclusions**

612 The types of fakery and fraud outlined will no doubt continue in the future, with
613 increasing sophistication (see the level of detail achieved in the Chinese feathered
614 dinosaurs). Economically-driven fraud or fakery is easy to understand yet particularly
615 ingenious in its execution. The origin of academic and aesthetic frauds or fakes is far
616 harder to define (see Goodstein [2010], and Trevors and Saier [2008]), wherein a few
617 crimes of this nature had little direct economic advantage for the perpetrator aside
618 from career advancement (Gupta), keeping their job (Depras) or gaining notoriety
619 (Baugh). The Piltdown Man, Gupta's displaced fossils and the feathered Chinese
620 dinosaurs are all good examples of where such activity had far-reaching
621 consequences for science: we hope that such fakes and frauds are not still in
622 existence, causing problems for those carrying out Earth science using both reliable
623 and unreliable evidence. [Some frauds \(e.g. mining\) have also had consequences for
624 how science is practiced and accredited as a profession and its findings can be used
625 to raise finance to capitalise upon its discoveries.](#) A healthy cynicism toward
626 spectacular fossil or mineral finds is hopefully borne of reading this article, which is
627 sad but perhaps necessary. [A sceptical attitude](#) This cynicism should now also be
628 directed to digital media as computer-assisted data handling will no doubt provide
629 opportunities for data theft and fakery (Merks [1992, 1993]). Web-based sources of
630 information have made intentional and inadvertent plagiarism more prevalent than
631 before: Nield (2009) summarises a debate at the British Science Festival (2009)
632 regarding the peer review process for journal articles. The majority view of the
633 participants was that reviews should detect plagiarism, but they quite often do not:
634 this comment may provide us a clue, given the digital age we live in, of likely future
635 geological fakes and frauds.

636

637 **Acknowledgements**

638 We thank Garth Earls ([Dalradian Gold Ltd. Geological Survey of N.Ireland](#)),
639 Andrew Ross (Natural History Museum, London), Bill Schneck ([Washington
640 State Patrol Microtrace Inc](#)), Jim Mallory ([Queen's University, Belfast](#)), [Raymond
641 Murray](#) (Missoula) and [Gareth Dyke \(University of Southampton\)](#) ~~William Brooks~~
642 ([USGS](#)) for their advice.

643

644

645 **References**

646

647 [Abbot, D.M., 2005. Investigating mining fraud. *Geotimes* 30-32.](#)

648 [Andvig, J.C., 1995. Corruption in the North Sea oil industry: Issues and assessments.](#)

649 [Crime, Law and Social Change. 23, 289-313.](#)

650 [Archaeology, 2010. <http://www.archaeology.org/>](#)

651 [online/features/hoaxes/calaveras.html \(no author\).](#)

652 [Barsoum, M. W., Ganguly, A., Hug, G., 2006. □Microstructural evidence of](#)

653 [reconstituted limestone blocks in the great Pyramids of Egypt, □*Journal of the*](#)

654 [American Ceramic Society 89, 3788-3796.](#)

655 [Bieri, F., \(2010\) *From Blood Diamonds to the Kimberley Process*, London: Ashgate.](#)

656 [Boles, J.D., 2008. Diamond detail and gem fraud status. *Journal of Financial*](#)

657 [Regulation and Compliance 16, 77-84.](#)

658 [Boylan, P., 2004. Museum specimens as sacred objects: the contrasting treatment of](#)

659 [the Piltdown Fraud of 1912 and that of Moulin Quignon, 1863. Conference](#)

660 [Abstracts: History of Geology Group at Burlington House, Geological Society of](#)

661 [London, October 22, 2004](#)

662 [Brook, T., 2004. Piltdown and Sussex: an uneasy relationship. Conference Abstracts:](#)

663 [History of Geology Group at Burlington House, Geological Society of London,](#)

664 [October 22, 2004.](#)

665 [Charig, A.J., Greenaway, F., Milner, A.N., Walker, C.A., Whybrow, P.J., 1986.](#)

666 [Archaeopteryx is not a forgery. *Science* 232, 622-626.](#)

667 [Clark, R.J.H., 2006. Raman microscopy as a structural and analytical tool in the fields](#)

668 [of art and archaeology. *Journal of Molecular Structure* 834-836, 74-80.](#)

669 [Coffee, J.C., 2001. Understanding Enron: It's about the Gatekeepers, Stupid.](#)

670 [Business Law 57, 1403.](#)

671 [Cole, J.R., Godfrey, L.R., Hastings, R.J., Schafersman, S.D., 1985. Creation vs.](#)

672 [Evolution. *National Center for Science Education* 15, 5 - 1.](#)

673 [Condon, M. \(1998\) *Making Disclosure: Ideas and Interests in Ontario Securities*](#)

674 [Regulation, Toronto: University of Toronto Press., 384 pp.](#)

675 [Craddock, P., 2009. *Scientific Investigation of Copies, Fakes and Forgeries.*](#)

676 [Butterworth-Heinemann \(Elsevier\), Oxford. 628 pp.](#)

677 [Dagbert, M., 2005. Geostatistics in resource/reserve estimation: a survey of the](#)
678 [Canadian mining industry practice. Quantitative Geology and Geostatistics -](#)
679 [Geostatistics Banff 2004. 14 345-350.](#)

680 [Durand-Delga., M. 1990. L'affaire Deprat. Travaux du Comite Francais d'Histoire de](#)
681 [la Geologie. 4, 117-212.](#)

682 [Forey, P. 2004. Fishy Business. Conference Abstracts: History of Geology Group at](#)
683 [Burlington House, Geological Society of London, October 22, 2004](#)

684 [Gashe, V., Finch, J., \(eds\). 2008. Current Research in Egyptology 2008: Proceedings](#)
685 [of the Ninth Annual Symposium, University of Manchester. Rutherford Press, 438](#)
686 [pp.](#)

687 [Goodstein, D., 2010. On Fact and Fraud: Cautionary Tales from the Front Lines of](#)
688 [Science. Princeton University Press, 184 pp.](#)

689 [Goold, D., Willis, A., 1997. The Bre-X Fraud. McClelland & Stewart. Pp 272.](#)

690 [Granier, B., Feist, M., Hennessey, E., Bucur, I.I., Senowbari-Dayan, B., 2009. The](#)
691 [Imam case. Additional investigation of a micropalaeontological fraud. Notebooks](#)
692 [on Geology. 4, 1-14.](#)

693 [Grimaldi, D.A., Shedrinsky, A., Ross, A., Baer, N.S., 2010. Forgeries of fossils in](#)
694 ['Amber': history, identification and case studies. Curator: the Museum Journal 37,](#)
695 [251-274.](#)

696 Halford, B. 2006. In search of concrete evidence: materials scientist suggests parts
697 of the Egyptian pyramids were made from reconstituted limestone. Chemical &
698 Engineering News 86 50-52.

699 [Healy, J. F., 1999. Pliny the Elder on science and technology. Oxford University](#)
700 [Press, 467 pp.](#)

701 [Heinrich, P.V., 1996. http://paleo.cc/paluxy/hein-ref.htm](#)

702 [Henry, J-L., 1994. The trilobites of the 'affaire Deprat'. Alcheringa: An Australian](#)
703 [Journal of Palaeontology 18, 359-362.](#)

704 [Hoyle, F., Wickramasinghe, N.C., Watkins, R.S., 1985., Archaeopteryx. British](#)
705 [Journal of Photography 132 693-694.](#)

706 [Hughes, A., 2006. Learning to trade ethically: knowledge capitalism, retailers and](#)
707 [contested commodity chains. Geoforum 37 1008-1020](#)

708 [Hughes, A., Wrigley, N., Buttle, M., 2008. Global production networks, ethical](#)
709 [campaigning and the embeddedness of responsible governance, Journal of](#)
710 [Economic Geography 8, 345-367](#)

Formatted: Normal, Justified, Tab stops: 0.5 cm, Left

Formatted: Font: 12 pt

Formatted: Font: 12 pt

Formatted: Font: 12 pt

Formatted: Font: 12 pt

Formatted: Font: 12 pt

Formatted: Font: 12 pt

Formatted: Font: 12 pt

Formatted: Font: 12 pt

Formatted: Font: 12 pt

Formatted: Font: 12 pt, Not Italic

Formatted: Font: 12 pt

Formatted: Font: 12 pt

711 [Hutchinson, B., 1998. Fool's Gold: The Making of Global Market Fraud. Alfred A.](#)
712 [Knopf, Publishers. 267 pp.](#)

713 [Huxley, T.H., 1864. Elements of Comparative Anatomy. John Churchill & Son,](#)
714 [London. 278 pp.](#)

715 [Kuban, G.J., 1989. A matter of degree: Carl Baugh's alleged credentials. National](#)
716 [Centre for Science Education Reports, 9, 6. \(Originally published in NCSE Reports](#)
717 [Vol 9, No. 6, Nov-Dec. 1989.\).](#)

718 [Latour, B., 2004. Why has critique run out of steam? From matters of fact to matters](#)
719 [of concern, Critical Inquiry 30, 225-248.](#)

720 [Lewin, R., 1989. The case of the misplaced fossils: a prominent Australian scientist](#)
721 [has examined two decades of work on ancient Himalayan geology and alleges it](#)
722 [may be the greatest paleontological fraud of all time. Science 244, 277-279.](#)

723 [Livingstone, D., 2003. Putting Science in its Place: Geographies of Scientific](#)
724 [Knowledge. Chicago: University of Chicago Press. 234 pp.](#)

725 [Maconachie, R., Binns, T., 2007. Beyond the resource curse? Diamond mining,](#)
726 [development and post-conflict reconstruction in Sierra Leone, Resources Policy](#)
727 [32, 104-115](#)

728 [Majury, N., 2007. Technology and the architecture of markets: reconfiguring the](#)
729 [Canadian equity market, Environment and Planning A 39\(9\) 2187-2206.](#)

730 [Mallot, J., 1982. Dr. Berinder's fossils: a study in the evolution of scientific world view,](#)
731 [Annals of Science 39\(4\), 371-380.](#)

732 [Martill, D., 1994. Fake fossils from Brazil. Geology Today 10, 111-115.](#)

733 [Mather, J., 2004. The mystique of cold groundwater – holy wells, spas, hydrothermics](#)
734 [and plastic bottles. Conference Abstracts: History of Geology Group at Burlington](#)
735 [House, Geological Society of London, October 22, 2004.](#)

736 [Matlins, A., Bonanno, A.C., 2009. Jewelry & Gems, the Buying Guide. Crown](#)
737 [Publishers, New York. 7th Edition. 457 pp.](#)

738 [McCrone, W.C., McCrone, L.B., 1974. The Vinland Map Ink. The Geographical](#)
739 [Journal 140, 212-214](#)

740 [Merks, J W., 1992. Geostatistics or voodoo science. The Northern Miner, May 18](#)
741 [Merks, J W., 1993. Abuse of statistics. California Institute of Mining, Bulletin 86, 966.](#)

Formatted: Indent: Left: 0 cm, Hanging: 0.5 cm, Line spacing: 1.5 lines, Tab stops: 0.5 cm, Left

Formatted: Font: 12 pt

Formatted: Font: 12 pt

Formatted: Font: 12 pt

Formatted: Font: 12 pt

- 742 [Murray, R., 2004. Evidence from the Earth. Mountain Press Publishing Co. Missoula,](#)
743 [Montana. 226 pp.](#)
- 744 [Naylor, R., 2007. The alchemy of fraud: investment scams in the precious-metals](#)
745 [mining business. Crime, Law and Social Change 47, 89-120.](#)
- 746 [Nield, E. 2009. Peering in.](#)
747 <http://www.geolsoc.org.uk/gsl/geoscientist/geonews/page6355.html>
- 748 [Osborne, R., 2000. The Deprat affair: ambition, revenge and deceit in French Indo-](#)
749 [China. Pimlico Books, London. 244 pp.](#)
- 750 [Pain, S., 2004. Histories: Johann Beringer and the fraudulent fossils, New Scientist](#)
751 [2479, 74.](#)
- 752 [Polikreti, K., 2007. The detection of ancient marble forgery: techniques and](#)
753 [limitations. Archaeometry 49, 603-619.](#)
- 754 [Polkinghorne, J., 1998. Belief in God in an Age of Science. New Haven, CT: Yale](#)
755 [University Press, 133 pp.](#)
- 756 [Ritchie, A., 1998. Will the real Dr. Snelling please stand up? The Skeptic 11, 12-15.](#)
- 757 [Rose, M., 2006. The Bosnia – Atlantis Connection. Archaeology, April 2006. Pp2-4.](#)
- 758 [Ross, A.J., 2004. Conference Abstracts: History of Geology Group at Burlington](#)
759 [House, Geological Society of London, October 22, 2004.](#)
- 760 [Ruffell, A., McKinley, J., 2008. Geoforensics. John Wiley & Son Ltd, Chichester. 340](#)
761 [pp.](#)
- 762 [Scientific American. 1856. Science and Art: Curious Use of the Microscope. Scientific](#)
763 [American, 11, \(30\), p.240. http://cdl.library.cornell.edu/cgi-](#)
764 [bin/moa/pageviewer?coll+moa&root=%2Fmoa%2Fs](#)
- 765 [Shapin, S., 1996. The Scientific Revolution, Chicago: University of Chicago Press.](#)
- 766 [Stos-Gale, Z.A., 1992. Isotope archaeology: reading the past in metals, minerals,](#)
767 [bone. Endeavour 16, 85-90.](#)
- 768 [Talent, J.A., 1989., The case of the peripatetic fossils. Nature 338, 613-615.](#)
- 769 [Torrens, H.S., 1998. Life, times and legacy of Mary Anning \(1799-1847\) fossilist.](#)
770 [Transactions of the Leicester Literary and Philosophical Society 92, 4-5.](#)
- 771 [Trevors, J.T., Saier, M.H., 2008. Corruption and fraud in Science. Water, Air & Soil](#)
772 [Pollution 189, 1-3.](#)
- 773 [Tsing, A., 2000. Inside the economy of appearances. Public Culture, 12\(1\):115-144:](#)
774 [DOI:10.1215/08992363-12-1-115.](#)

- 775 [Whyte, J., Danielson, V., 1997. V. Bre-X: Gold Today, Gone Tomorrow. Northern](#)
776 [Miners Press, 304 pp.](#)
- 777 [Wieseman M.E., 2010. A Closer Look: Deceptions and Discoveries, National](#)
778 [Museum, London 2010, pp. 78–81](#)
- 779 [Wilford, J.N., 1998. Earliest known fake stone is discovered in Southern Iraq. The](#)
780 [New York Times. \[http://www.nytimes.com/1998/06/30/science/earliest-known-\]\(http://www.nytimes.com/1998/06/30/science/earliest-known-fake-stone-is-discovered-in-southern-iraq.html\)](#)
781 [fake-stone-is-discovered-in-southern-iraq.html](#)
- 782 [Abbot, D.M., 2005. Investigating mining fraud. *Geotimes* 30–32.](#)
- 783 [Andvig, J.C., 1995. Corruption in the North Sea oil industry: Issues and assessments.](#)
784 [Crime, Law and Social Change. 23–289–313.](#)
- 785 [Archaeology, 2010. \[http://www.archaeology.org/\]\(http://www.archaeology.org/online/features/hoaxes/calaveras.html\)](#)
786 [online/features/hoaxes/calaveras.html \(no author\).](#)
- 787 [Barsoum, M. W., Ganguly, A., Hug, G., 2006. □Microstructural evidence of](#)
788 [reconstituted limestone blocks in the great Pyramids of Egypt, □Journal of the](#)
789 [American Ceramic Society 89 3788–3796.](#)
- 790 [Boles, J.D., 2008. Diamond detail and gem fraud status. *Journal of Financial*](#)
791 [Regulation and Compliance. 16–77–84.](#)
- 792 [Boylan, P., 2004. Museum specimens as sacred objects: the contrasting treatment of](#)
793 [the Piltdown Fraud of 1912 and that of Moulin Quignon, 1863. Conference Abstracts:](#)
794 [History of Geology Group at Burlington House, Geological Society of London,](#)
795 [October 22, 2004](#)
- 796 [Brook, T., 2004. Piltdown and Sussex: an uneasy relationship. Conference Abstracts:](#)
797 [History of Geology Group at Burlington House, Geological Society of London,](#)
798 [October 22, 2004.](#)
- 799 [Charig, A.J., Greenaway, F., Milner, A.N., Walker, C.A., Whybrow, P.J. 1986.](#)
800 [Archaeopteryx is not a forgery. *Science*, 232 622–626.](#)
- 801 [Clark, R.J.H., 2006. Raman microscopy as a structural and analytical tool in the fields](#)
802 [of art and archaeology. *Journal of Molecular Structure*, 834–836 74–80.](#)
- 803 [Coffee, J.C., 2001. Understanding Enron: It's about the Gatekeepers, *Stupid*. 57](#)
804 [Busines Law 1403.](#)
- 805 [Cole, J.R., Godfrey, L.R., Hastings, R.J., Schafersman, S.D., 1985. Creation vs.](#)
806 [Evolution. National Center for Science Education. 15–5–1.](#)
- 807 [Graddock, P., 2009. Scientific Investigation of Copies, Fakes and Forgeries.](#)
808 [Butterworth Heinemann \(Elsevier\), Oxford. 628 pp.](#)

- 809 Durand-Delga, M. 1990. L'affaire Deprat. *Travaux du Comité Français d'Histoire de*
810 *la Géologie*, 4 117-212.
- 811 Farmer, N.L., Ruffell, A., Meier-Augenstein, W., Meneely, J., Kalin, R.M., 2006.
812 *Forensic analysis of wooden safety matches. Science & Justice* 46 88-98.
- 813 Forey, P. 2004. *Fishy Business. Conference Abstracts: History of Geology Group at*
814 *Burlington House, Geological Society of London, October 22, 2004*
- 815 Gashe, V., Finch, J. (eds). 2008. *Current Research in Egyptology 2008: Proceedings*
816 *of the Ninth Annual Symposium, University of Manchester. Rutherford Press, 438pp.*
- 817 Goold, D. & Willis, A., 1997. *The Bre-X Fraud. McClelland & Stewart. Pp272.*
- 818 Goodstein, D., 2010. *On Fact and Fraud: Cautionary Tales from the Front Lines of*
819 *Science. Princeton University Press, 184 pp.*
- 820 Granier, B., Feist, M., Hennessey, E., Bucur, I.I., Senowbari-Dayan, B., 2009. *The*
821 *Imam case. Additional investigation of a micropalaeontological fraud. Notebooks on*
822 *Geology*, 4 1-14.
- 823 Grimaldi, D.A., Shedrinsky, A., Ross, A., Baer, N.S., 2010. *Forgeries of fossils in*
824 *'Amber': history, identification and case studies. Curator: the Museum Journal* 37
825 251-274.
- 826 Healy, J. F., 1999. *Pliny the Elder on science and technology. Oxford University*
827 *Press. Pp. 467.*
- 828 Henry, J. L., 1994. *The trilobites of the 'affaire Deprat'. Alcheringa: An Australian*
829 *Journal of Palaeontology*, 18 359-362.
- 830 Heinrich, P.V., 1996. http://paleo.cc/paluxy/hein_ref.htm
- 831 Hoyle, F., Wickramasinghe, N.C., Watkins, R.S., 1985. *Archaeopteryx. British Journal*
832 *of Photography*, 132 693-694.
- 833 Hutchinson, B., 1998. *Fool's Gold: The Making of Global Market Fraud. Alfred A.*
834 *Knopf, Publishers. 267pp*
- 835 Huxley, T.H., 1864. *Elements of Comparative Anatomy. John Churchill & Son,*
836 *London. 278pp.*
- 837 Kuban, G.J., 1989. *A matter of degree: Carl Baugh's alleged credentials. National*
838 *Centre for Science Education Reports*, 9, 6. (Originally published in *NCSE Reports*
839 *Vol 9, No. 6, Nov-Dec. 1989.*)
- 840 Lewin, R., 1989. *The case of the misplaced fossils: a prominent Australian scientist*
841 *has examined two decades of work on ancient Himalayan geology and alleges it may*
842 *be the greatest paleontological fraud of all time. Science* 244, 277-279.

- 843 [Martill, D., 1994. Fake fossils from Brazil. *Geology Today* 10, 111-115.](#)
- 844 [Matlins, A., Bonanno, A.C., 2009. *Jewelry & Gems, the Buying Guide*. Crown](#)
- 845 [Publishers, New York. 7th Edition. 457 pp.](#)
- 846 [Mather, J., 2004. The mystique of cold groundwater—holy wells, spas, hydropathics](#)
- 847 [and plastic bottles. Conference Abstracts: History of Geology Group at Burlington](#)
- 848 [House, Geological Society of London, October 22, 2004.](#)
- 849 [Merks, J.W., 1992. Geostatistics or voodoo science, *The Northern Miner*, May 18](#)
- 850 [Merks, J.W., 1993. Abuse of statistics, *California Institute of Mining, Bulletin* 86, 966.](#)
- 851 [McCrone, W.C., McCrone, L.B., 1974. The Vinland Map Ink. *The Geographical*](#)
- 852 [Journal](#) 140-212-214
- 853 [Morgan, R.M., Wiltshire, P.E.J., Parker, A., Bull, P., 2006. The role of forensic](#)
- 854 [geoscience in wildlife crime detection. *Forensic Science International* 162 152-162.](#)
- 855 [Murray, R., 2004. *Evidence from the Earth*. Mountain Press Publishing Co. Missoula,](#)
- 856 [Montana. 226 pp.](#)
- 857 [Nature, 2006. Materials science: concrete evidence. 444, p. 793](#)
- 858 [Naylor, R., 2007. The alchemy of fraud: investment scams in the precious metals](#)
- 859 [mining business. *Crime, Law and Social Change*, 47 89-120.](#)
- 860 [Nield, E. 2009. Peering in.](#)
- 861 <http://www.geolsoc.org.uk/gsl/geoscientist/geonews/page6355.html>
- 862 [Osborne, R., 2000. *The Deprat affair: ambition, revenge and deceit in French Indo-*](#)
- 863 [China. Pimlico Books, London. 244pp.](#)
- 864 [Pain, S., 2004. Histories: Johann Beringer and the fraudulent fossils. *New Scientist*,](#)
- 865 [25-December-2004.](#)
- 866 [Polikreti, K., 2007. The detection of ancient marble forgery: techniques and](#)
- 867 [limitations. *Archaeometry*, 49 603-619.](#)
- 868 [Ritchie, A., 1998. Will the real Dr. Snelling please stand up? *The Skeptic*, 11-12-15.](#)
- 869 [Rose, M., 2006. The Bosnia—Atlantis Connection. *Archaeology*, April 2006. Pp2-4.](#)
- 870 [Ross, A.J., 2004. Conference Abstracts: History of Geology Group at Burlington](#)
- 871 [House, Geological Society of London, October 22, 2004.](#)

- 872 [Ruffell, A., McKinley, J., 2008. Geoforensics. John Wiley & Son Ltd, Chichester.](#)
- 873 [Scientific American. 1856. Science and Art: Curious Use of the Microscope. Scientific](#)
- 874 [American, 11, \(30\), p.240. \[http://cdl.library.cornell.edu/cgi-\]\(http://cdl.library.cornell.edu/cgi-bin/moa/pageviewer?coll+moa&root=%2Fmoa%2Fs\)](#)
- 875 [bin/moa/pageviewer?coll+moa&root=%2Fmoa%2Fs](#)
- 876 [Science & Vie, 2006. Science & Vie publish 10 pages on the Geopolymers of the](#)
- 877 [Pyramids. 1071, Décembre 2006.](#)
- 878 [Stos-Gale, Z.A., 1992. Isotope archaeology: reading the past in metals, minerals,](#)
- 879 [bone. Endeavour, 16, 85-90.](#)
- 880 [Talent, J.A., 1989. The case of the peripatetic fossils. Nature, 338, 613-615.](#)
- 881 [Torrens, H.S., 1998. Life, times and legacy of Mary Anning \(1799-1847\) fossilist.](#)
- 882 [Transactions of the Leicester Literary and Philosophical Society, 92, 4-5.](#)
- 883 [Trevors, J.T., Saier, M.H., 2008. Corruption and fraud in Science. Water, Air & Soil](#)
- 884 [Pollution 189, 1-3.](#)
- 885 [Tsing, A., 2000. Inside the economy of appearances. Public Culture, 12\(1\):115-144;](#)
- 886 [DOI:10.1215/08902363-12-1-115.](#)
- 887 [Wieseman M.E., 2010. A Closer Look: Deceptions and Discoveries, National](#)
- 888 [Museum, London 2010, pp. 78-81](#)
- 889 [Wilford, J.N., 1998. Earliest known fake stone is discovered in Southern Iraq. The](#)
- 890 [New York Times. \[http://www.nytimes.com/1998/06/30/science/earliest-known-fake-\]\(http://www.nytimes.com/1998/06/30/science/earliest-known-fake-stone-is-discovered-in-southern-iraq.html\)](#)
- 891 [stone-is-discovered-in-southern-iraq.html](#)
- 892 [Whyte, J., Danielson, V., 1997. V. Bre X: Gold Today, Gone Tomorrow. Northern](#)
- 893 [Miners Press, 304pp.](#)