

Teaching Earth Sciences

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'Killer facts' supporting geology in schools and colleges

What 'killer facts' would persuade your Head, governors and Senior Managers that it is vitally important for them to support GCSE and/or A-level geology?

What 'killer facts' will help you to 'bang the drum' when you want geology to continue in this season of austerity and staffing cuts, or you want to launch a brand new geology course in your school/college?

Some of these may be the key 'killer facts' for you:

- Students perform better in geology than they do in other science subjects
- The AS to A2 staying on rate is better in geology than in other science subjects
- Geology contains elements of all the STEM subjects – critical for those who want to continue studying a science
- Geology is seen as a 'relevant' and accessible subject, often more so than other science subjects
- Geology gives the school/college a 'unique selling point' (USP)
- Geology interests both girls and boys
- Geology is a popular subject
- Opportunities for further study of Earth science are as extensive as for other science subjects
- The UK needs geologists
- Geologists are well paid
- Geology plays a vital role in supporting the economy of the UK
- The UK has a crucial geological legacy
- The UK has a more complete geological sequence, and so greater geological variety and teaching potential, than any other country of its size on Earth
- Geology teachers are often highly-regarded and well-loved

Read on for more background to all these key points.

Students perform better in geology than they do in other science subjects

An Ofqual analysis in 2015 showed that A-level geology candidates achieved between 0.6 and 1 grade higher than students of an equal general ability who took other science subjects (biology, chemistry, physics). See Box 1.

Box 1. Ben Jones, Head of Standards in the Centre for Education Research and Practice at the Awarding Body AQA, has written:

'As part of its programme investigating inter-subject comparability (ISC), in 2015, Ofqual published ISC Working Paper 3: "Inter-Subject Comparability of Exam Standards in GCSE and A level (https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/486936/3-inter-subject-comparability-of-exam-standards-in-gcse-and-a-level.pdf). This comprised a multi-method statistical analysis, the prime approach taken being the application of the Rasch model (although all models yielded similar results).

Several strong caveats and assumptions underpin the analyses, primarily that between subjects "other things (e.g. motivation) remain equal". The sole control variable used to ensure such equality on one dimension at least comprised a measure of students' general ability.

According to the results of the analysis, A level Geology is placed near the middle. Of particular note is that compared to students with equivalent overall ability levels in the "cognate subjects" of Biology, Chemistry, Physics (though not Geography), Geology students tended to be awarded around +0.6 to +1.0 grade higher.'

The AS to A2 staying on rate is better in geology than in other science subjects

Data produced by the inter-board Joint Council for Qualifications (JCQ) shows that the 'retention' (or 'staying on') rate for geology from AS to A2-level for the past three years was significantly higher than for biology, chemistry or physics. See Box 2.

Geology contains elements of all the STEM subjects – critical for those who want to continue studying a science

Nikki Edwards, ESTA Chair, has recently carried out an analysis of GCSE geology which clearly showed that the geology specification contains significant elements of biology, chemistry, physics, Maths and engineering (the STEM subjects). See Box 3 and Figure 1.

Box 2. Chae Cruickshank, Science Subject Advisor and Geology Subject Officer for the Awarding Body OCR, has written: 'I have compiled the figures from the JCQ for the cohorts starting AS in September 2013 to 2015 (these are the last three years of the legacy Tranche 1 sciences). This shows the same trend as the internal OCR data.'

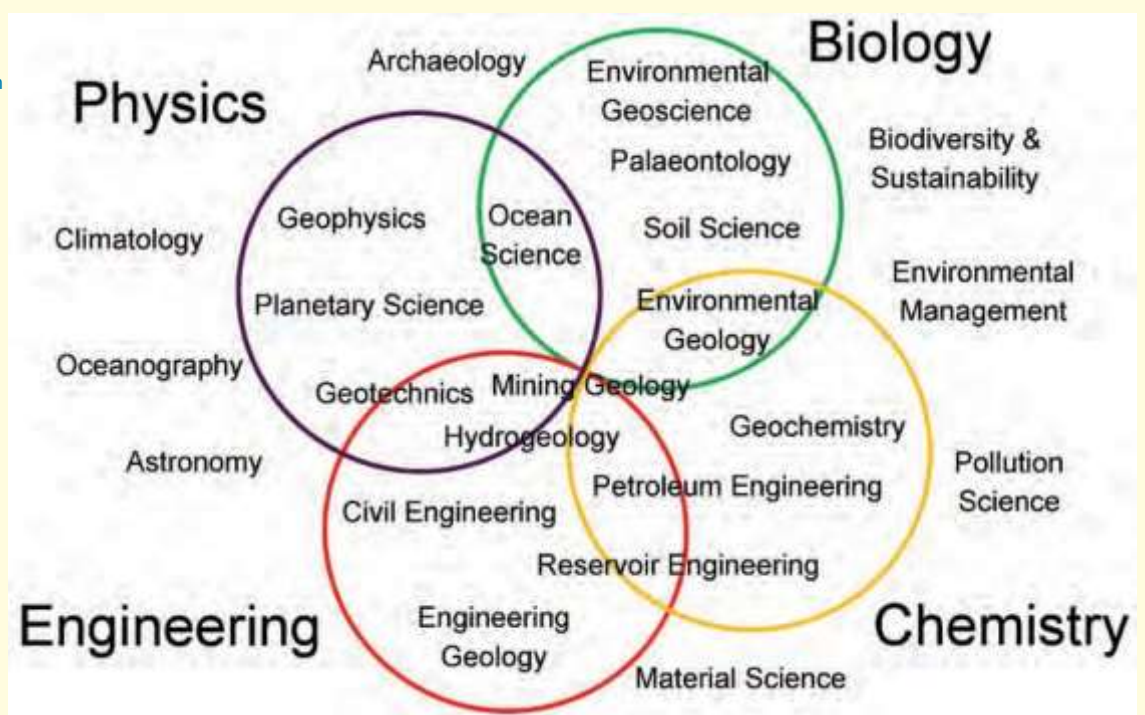
Subject	2013 AS entries			2014 AS entries			2015 AS entries			Mean %
	AS	A2	%	AS	A2	%	AS	A2	%	
Biology	103905	64070	61.7%	105251	63275	60.1%	103859	62650	60.3%	60.7%
Chemistry	85631	53513	62.5%	88673	52644	59.4%	87621	51811	59.1%	60.3%
Geology	3396	2348	69.1%	3576	2242	62.7%	3313	2115	63.8%	65.2%
Physics	61176	36701	60.0%	64790	36287	56.0%	64377	35344	54.9%	57.0%

Box 3. Emma Smith, geology teacher at Gairloch in Scotland, has written: 'One of the key things for me was selling Geology as a contributor to every aspect of STEM – at a time when the STEM curriculum is being pushed I was able to propose a certificated course which really did branch into all of these subjects where most pure sciences offered at school level did not.'

One example is geophysics, here being investigated in the field. Photograph Peter Kennett.



Figure 1: Venn diagram prepared by Chae Cruickshank (OCR) of the overlap between geology and other areas of science.



Geology is seen as a 'relevant' and accessible subject, often more so than other science subjects

Experience has shown that geology can explain the physical outdoor world in ways not readily accessed by other science subjects. See Box 4.

Box 4. Elizabeth Devon, retired geology teacher from Stonar School and co-initiator of the Earthlearningidea project, has written:

'Pupils (especially sixth formers) view [geology] as a 'relevant' subject. It is about the world around them from landscapes to mineral wealth to the environment; it explains what they can see and relate to in a way the other sciences do not. It also has the unique fieldwork aspect where pupils are asked to work out what they see, to imagine what conditions were like in the past. It is a subject where everyone can contribute something and, in fact, is accessible to all.'

Fieldwork in action. Photograph Peter Kennett.



Geology gives the school/college a 'unique selling point' (USP)

Teaching geology gives a school/college many strong selling points that can be used to promote the institution. A particular case study is Truro School, which employed a company to identify its strengths and weaknesses in terms in attracting students and parents – the results showed that the fact that geology was an excellent department, and achieved higher grades and success than other subjects, was a major factor. See Box 5.

Ryan Lawson, Head of Geology at South Down College, adds, 'I have managed to increase my applicants for A-level Geology for next year by 15% mainly through school visits, open days and other members of the science department using Geology as a unique selling point during interviews etc.'

Box 5. Ian Kenyon, ex-Head of Department of Geology at Truro independent school in Cornwall, has written:

'Just over three years ago a company was employed by Truro School to identify its strengths and weaknesses in terms of what attracted pupils to the school.

The results showed that parents were aware that Geology was a department of excellence and that students achieved higher grades in this subject compared to other subjects.

A number of parents stated that the fact that Truro School offered Geology at GCSE and A-level, was a major factor in sending their sons/daughters to Truro School.

Parents were aware of the track record of the Geology Department as we had won numerous awards for outstanding results at A level and GCSE.

Truro School website has many photos of Geology field trips and the SLT actively acknowledge the importance of the subject on the curriculum and its relevance in Cornwall's history and culture. In fact, they fully support field-based learning and never question the vast number of field trips that the department organises.

An overseas trip to Tenerife in December each year over the past 16 years has also helped to maintain a high profile for the subject. As an A2 trip this has ensured a virtually zero dropout rate at AS in Geology.

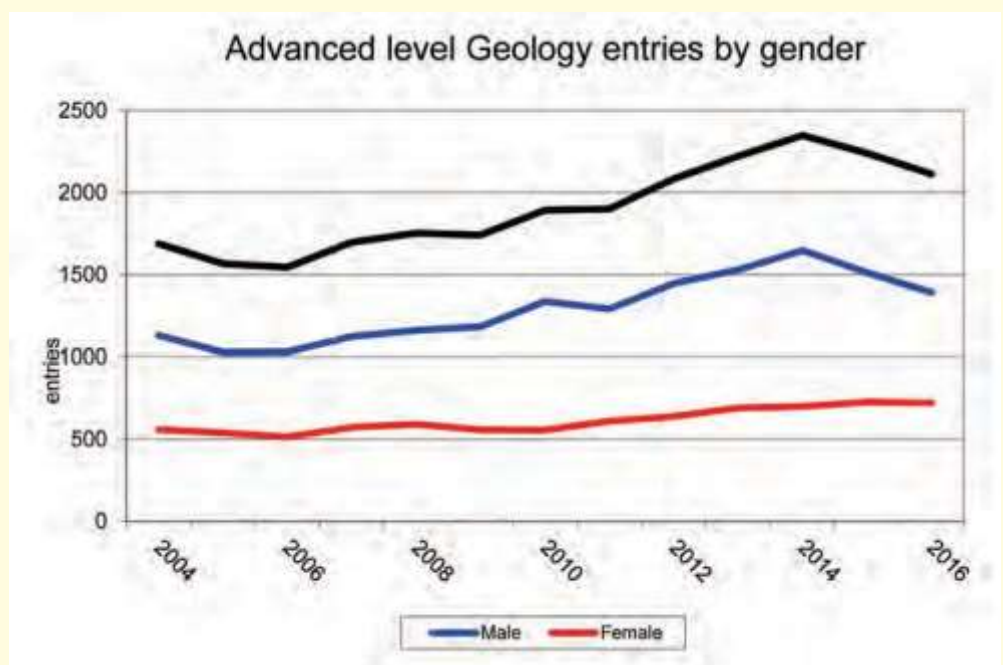
The profile of Geology at Truro School and the publicity on our website has attracted students from Greece, Russia, China, Germany, Slovenia and Nigeria to attend Truro School because of our reputation for excellence in geological education.

Parents have commented that if you search on Google™ for 'best school for geology in the UK', Truro School is one of the first to come up on the search results.'

Some photos of the department are below. Photographs Ian Kenyon.



Figure 2: A-level geology entry, 2004 – 2016.



Geology interests both girls and boys

Candidate data in recent years has shown that A-level entries have been around 2/3 male and 1/3 female. However, in the past two years, whilst male entry has declined, female entry has remained stable. See Figure 2.

Probably the 'killer facts' discussed so far are the most likely to persuade senior management of the importance of continuing/launching a GCSE or A-level geology course. Nevertheless, there are many other reasons why schools and colleges should support the teaching of GCSE and A-level geology, as highlighted below.

Geology is a popular subject

Geology is usually a popular subject in institutions where it is offered, and in some school/colleges, it is the most popular science subject. See Box 6.

Box 6: Chae Cruikshank, Science Subject Advisor and Geology Subject Officer for the Awarding Body OCR, has written:

'In centres which offer A level Geology, it competes very well with the other sciences, and attracts students who may not otherwise take a science A level; an analysis of A level entry data by OCR showed that in 1:10 centres of all sizes, geology was the most popular science by entry, and in most other centres, competed with Chemistry as the second science, it was only in those centres where other factors were imposed (such as a limit numbers or reduced time allocated) that geology was less popular.'

Opportunities for further study of Earth science are as extensive as for other science subjects

The possibilities for studying Earth science-related subjects at university are just as wide as for other science subjects. See Box 7.

Box 7: Chae Cruikshank, Science Subject Advisor and Geology Subject Officer for the Awarding Body OCR, has also written:

'Opportunities to study Earth Science at university are as extensive as for Chemistry (around 6000 places) and if Civil Engineering is included then they are as large as for Biology (www.hesa.ac.uk). Earth Science is a broad discipline which includes traditional Geology courses (including Imperial College where Geology was ranked No1 for any STEM course in 2016, Daily Mail 25.10.16) and a wide range of other opportunities such as environmental science, geochemistry, marine science, palaeontology and petroleum geology. ... students from centres which offer Geology (at GCSE or A level) are 19 times more likely to go on to study Earth Science.'

The UK needs geologists

- That the country needs geologists is evidenced by the fact that the latest published UK government 'Shortage Occupation' list (at: <https://www.gov.uk/guidance/immigration-rules/immigration-rules-appendix-k-shortage-occupation-list>) lists ten geoscience-related shortage jobs (including geologist) and only one physics-related job (geophysicist), one chemistry-related job (geochemist), one biology-related job (bio-information technician) and no geography-related jobs.
- More than 40% of applicants for undergraduate geology degrees have A-level geology (UCAS data 2010, 2012).
- 44% of students who gained A-level geology that went on to university, studied for a geoscience degree (Earth Science Teachers' Association, ESTA, data 2009-2014).

Geologists are well paid

The salaries of geologists are higher than those of many other professionals, see Box 8.

Box 8: Kevin Stephen, Head of Geology at Altrincham Grammar School for Boys, and Paul Grant at Imperial College have alerted us to the article published in the *Times* newspaper in September 2016 at, <https://www.thetimes.co.uk/article/geologists-hit-gold-with-best-graduate-pay-nvrhkdw3> which has, 'Geologists at Imperial College London have emerged as the top-earners in a league table of graduate salaries published today alongside the Sunday Times Good Universities Guide. Their average wage of £73,267 six months after leaving university surpasses that of medics and engineers.'

Kevin has also alerted us to the 'What do graduates earn' section of the 'Complete University Guide' found at: <https://www.thecompleteuniversityguide.co.uk/careers/what-do-graduates-do-and-earn/what-do-graduates-earn/>, which lists mean professional starting salaries for subject groups for first time graduates who completed their degrees in 2014-15. This shows that, of the 70 subject areas listed, geology is 17th at £24,818.

The list ranges from dentistry at the top (£30,432) to optometry, ophthalmology and orthoptics at the bottom (£16,286) with an overall mean of £22,984.

Geology plays a vital role in supporting the economy of the UK

A recent Council for British Industry (CBI) report has highlighted the key role played in particular by the minerals industry, in supporting the UK economy. See Box 9.

The UK has a crucial geological legacy

- Key contributions to the understanding of global geoscience have been made by UK geologists, including discoveries of: geological time (Hutton); the 'present is the key to the past' (Lyell); the geological 'map that changed the world' (Smith); evolution (Darwin); how mountains form (Peach and Horne); the age of the Earth (Holmes); how sea floors spread in plate tectonics (Vine and Matthews); how the Earth's plates move (McKenzie); and how the Earth system works (Lovelock).
- Of the 12 periods of geological time, four were first recognised and described in the UK.
- The UK has the first recorded 'professional' female geologist – Mary Anning (she was 'professional' in that she made her income by finding and selling fossils) (Figure 3).

Box 9: Iain Stewart, Professor of Geoscience Communication at the University of Plymouth has written:

'You had a specific query about contribution of raw materials to UK economy which this should answer:

<http://www.cbi.org.uk/news/minerals-critical-to-the-uk-economy/cbi-report-the-uk-mineral-extraction-industry/>

The CBI report carries the following comments:

'Minerals directly contribute to the UK economy by generating £235bn in gross value added, representing 16% of the total UK economy.' (p5)

'Excluding oil and gas, mineral extraction employs 34,000 people and is 2.5 times more productive than the UK average.' (p6)

'The economy simply could not function without minerals. Without them, life as we know it could not be sustained on its current scale. The message ... is clear: minerals underpin everything in the UK economy.' (p4)

'The mineral extraction industry is vital to the economy and our way of life. Minerals are essential, representing the largest material flow in the economy and should not be taken for granted. Indeed it is hoped that ... their role and contribution will finally be recognised and valued by Government and all stakeholders, and that the industry can influence a shift to a more positive perception of what it does.' (piii)



Figure 3: The door of the Mary Anning room at Truro School.

The UK has a more complete geological sequence, and so greater geological variety and teaching potential, than any other country of its size on Earth

- The UK has rocks from every geological epoch (subsection of a geological period) except one.
- The UK rock sequence has evidence from four mountain-building episodes (Precambrian, Caledonian, Variscan and Alpine).

Box 10: Ray Humphreys, recently retired Head of Geology from Alun School, Mold, has sent some of the feedback he received on his retirement, which included:

‘Hi, Congratulations on a well-deserved retirement. You had such a massive impact on my life and the direction it took, I can’t thank you enough’.

‘Your passion for the subject is infectious, and I wouldn’t be doing what I am now without your influence and encouragement’

‘The best teacher and fellow geologist I know.’

‘I know I wasn’t your best pupil, but you were my best teacher by a country mile.’

Peter Kennett, ex-Head of geology at High Storrs School, and co-initiator of the Earthlearningidea project has added: ‘I derive considerable pleasure when encountering old students who did not follow a geological career, but who open the conversation with, “Oh, I was thinking of you the other day, when I was sitting up on a crag in the Lake District/ North Wales/Canary Islands/Greece and wondering about the geology I could see……!”’

Peter goes on to add, ‘No doubt, experiences like these will be common to almost any teacher of geology who has been in the game for enough years, and many other ESTA members would be able to contribute similar stories if they were not so modest!’

Geology teachers are often highly-regarded and well-loved

Many geology teachers can recount feedback or meetings with former students showing that their impact on the lives of the students has been vital, see Box 10.

In conclusion

In these difficult times, we might all be faced with a challenging fight to protect geology in our schools, colleges and educational system. But with ‘killer facts’ like these and the reputation ESTA and geology teachers have for fighting for their corners – I’m confident that we will come through these tough times, and may even be leaner but fitter afterwards.

If anybody can contribute more ‘killer facts’ to be used in protecting and developing geology in UK schools, colleges and beyond – please send a ‘Letter to the Editor’

highlighting these key pieces of information – so that the message can be carried forward through future editions of *Teaching Earth Sciences*.

Note: Data from 2016 shows that:

- A-level entry was 2113
- AS-level entry was 2905
- GCSE entry was 993
- More than 200 centres were teaching GCSE and A-level geology

These are the figures we need to protect and develop.

Acknowledgement

Many thanks indeed to all those ESTA members and others who have contributed thoughts and/or words to this article. May the battle continue ...!

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