

Appendix 1. Essential skills and techniques

Departments applying for accreditation will be required to demonstrate that their programmes introduce students to the major aspects of their degree subject and specifically that appropriate skill levels are attained in certain highlighted topics. They must also demonstrate that teaching in these subjects is carried out by appropriately qualified staff with relevant postgraduate research and/or professional experience as appropriate, and a record of continuing professional development. This applies particularly to fieldwork where we consider the teaching of mapping skills to be of very high importance.

1. All degree schemes must expose students to methods and ideas across a spectrum of the earth sciences, although the details will vary with degree title. In particular, it must be shown that the curricula for all accredited programmes have the following themes embedded:

- (a) The importance of time and scale in geology, including the 4D investigation of sedimentary sequences, igneous and metamorphic processes and tectonics.
- (b) The contributions of cognate sciences to geological understanding through geochemistry and geophysics.
- (c) An understanding of surface processes including those affecting landscape development in the Quaternary.
- (d) An awareness of the essential contributions of geoscience to the economic, environmental and cultural needs of Society.

2. In addition, the following essential skills must be addressed in each programme. Table 1 indicates the amount of work required as a minimum in each of these. While it is acceptable for programmes to teach one of these skills at the minimum level, each programme must exceed minimum levels in other skills to compensate. The minimum levels are intended to be the expectation for a programme whose efforts are concentrated on other skill topics and so a low performance across the board will not be accredited.

- (a) Practical experience of a range of rocks, structures, landforms etc. in the field, including experience in instrumental and sampling techniques in the field. Field-based project work is included in this category, although it is recognised that there will be individual cases where independent project work cannot be carried out in the field. It is expected that graduates in Geological Sciences (or similarly titled) degree schemes will be trained in geological mapping and will practice it independently as part of their project work, but it is recognised that in some other degree schemes more emphasis should be placed on instrumental methods, sampling techniques, etc. and that in these the projects will include laboratory training.
- (b) The ability to describe geological materials and their properties at a range of scales and reach informed conclusions about their possible identity and origins. This includes the investigation of sediments, rocks, minerals and fossils, although the balance between specific topics may vary. Lecture and practical classes should be supported by field exercises.
- (c) Facility with visualising geological data in three dimensions, including the construction of cross sections, extraction of 3D orientations from observations on a 2D surface and manipulation of data via stereonet.
- (d) Some exposure to the handling of large data sets using GIS techniques and the use of remote sensing techniques.
- (e) Mathematical and statistical skills necessary to understand the quantitative and theoretical aspects of the subject and to handle data sets. Departments should document the provision made, although it is recognised that this may be by special courses and/or by material embedded in specific modules, and that requirements may vary according to A-level qualifications (see Appendix 2). In addition, it is expected that students will have acquired competence in the Graduate Key Skills as set out in Section 3 of the QAA Benchmark Statement for Earth Sciences, Environmental Sciences and Environmental Studies (2007).

While these two lists represent essential requirements, it is expected that accredited degrees will give students the opportunity to acquire skills relevant to all the major employment sectors for UK graduates, including hydrocarbons, engineering, environment, hydrogeology, economic minerals and aggregates, except where the degree programme is clearly intended to educate students along a more specialised pathway. Submissions should demonstrate that this is indeed the case.

Where compliance with these requirements is not adequately demonstrated by the spreadsheets, a brief narrative explanation should be given.

Appendix 2. Essential mathematical, statistical and computing techniques for geoscience programmes

<i>Field</i>	<i>Core topics</i>
General approach	Understanding and stating the problem, converting words to equations, approximation, dimensional analysis, order of magnitude calculations
Numbers and functions	Percentages, square roots, powers, logs (base 10 and natural) and exponentials
Dimensions and units	Understand importance of the dimension of a value (e.g. area must be length ² , some numbers dimensionless). Evaluating dimensions from an equation. SI units and prefixes (milli, micro etc.).
Geometry	Areas (triangle, rectangle, circle), volumes (cuboid, prism, sphere), estimating volumes of irregular bodies.
Trigonometry and simple vectors	Pythagoras. Radians \leftrightarrow degrees, sine, cosine, tangent in right angle triangles. Applications to mapping and map work, including grid references, latitude, longitude; dip, strike and measurement of sections.
Algebra	Fundamentals of algebra. Manipulation of equations involving the above functions.
Statistics	Geological data sources and sampling protocols. Empirical frequency distributions – histogram. Measures of location – mean, median, mode. Measures of spread – standard deviation, standard error, range. Percentiles. Box plot. Gaussian (Normal) distribution. Lognormal distribution. Discrete distributions – count data. Bar charts. Percentaged data. Cartesian coordinates. Bivariate scatter (xy) plot. Ternary diagram. Geographically distributed data. Mapping. Point-value data. Contouring methods. Circular directional data – rose diagram. Spherical directional data – equal-area stereographic projection. Mean vector. Bivariate correlation. Fitting linear equations.
Computing and data management, including spreadsheets (Excel or equivalent)	Use of computing programmes for all aspects of IT. Familiarity with applications software (i.e. 3D mapping programmes, seismic interpretation software, ArcGIS, etc.). For spreadsheets: calculating cell contents, using a range of functions, copying cells to manipulate large data sets, plotting, formatting sheets and plots.
Rudiments of calculus	Students should be able to read differential equations and understand the relationships between variables in the context of rates of change of geological processes; also to understand the principles of integration.

All students should be expected to make use of the core topics in a range of modules on a routine basis throughout their degree. It is also expected that more advanced numerical methods may be introduced as appropriate in specific modules, but it is recognised that the diversity of modules on offer makes it inappropriate to define specific content.

In their submissions departments must demonstrate, in a separate appendix, how and where numerical methods are taught and applied throughout the course of their degree schemes.

Table 1. Minimum time devoted to essential skills (BSc and MSci programmes)

Programme group	Geology	Environmental Geology/ Geochemistry	Applied Geology/ Engineering Geology	Geophysics (Geological)	Geophysics (Maths/Physics)	Geoscience programmes with ca.60%-80% geoscience	Geoscience programmes with ca 50%-60% geoscience
Total Field Days (Level M suppl) ¹	60 (+4)	37 (+4)	37 (+4)	32 (+4)	30	35 (+2)	35 (+2)
Independent Project (credits) ²	30	30	30	30	30	30	30 ³
Independent Project (field days) ⁴	24	7	7	7	7	7	7
Independent Mapping (field days)	18	7 ⁵	7 ⁵	7 ⁵	0	7 ⁵	7 ⁵
Materials: Rocks, Minerals (total credits) ^{6,7}	30	25	30	25	15	20	15
Materials: Rocks, Minerals (practical hours)	55	45	55	45	25	40	30
Fossils (total credits)	10	5	5	0	0	5	5
Fossils (practical hours)	20	10	10	0	0	10	10
Structural Geology/ maps (practical hrs) ⁷	30	20	30	30	30	20	15
GIS / Remote Sensing (credits)	5	5	5	5	5	5	5
Total taught Earth Sciences Level 2 (credits/yr) ⁸	60	60	60	60	60	60	40
Total taught Earth Sciences Levels 3 and M (credits/yr) ⁸	110	110	110	110	110	80	60

¹ Integrated masters degrees are expected to include additional field days specific to that degree, which should be taken at either the Level M year or the preceding year. Total Field Days include the independent project field days.

² In this table “credits” refer to standard HEFCE credits such that each level of full time study comprises 120 credits.

³ At least 20 credits should be geoscience based.

⁴ For some degree schemes independent fieldwork is expected, but field project work is more appropriate in areas such as Environmental Geochemistry or Geophysics and involves fewer days. This category includes group fieldwork for the purpose of collecting data/materials for use in Independent Projects.

⁵ The requirement for independent mapping may form the whole or part of the Independent Project (where the length of this either meets or exceeds the minimum requirement for independent mapping), or may be completed as a separate exercise. In the case of Geophysics (Geological), the Panel will accept alternative field or practical work if this can be shown to satisfy training in the ability to visualise geological data in 3D.

⁶ Rocks – Petrography and petrology of Igneous, Sedimentary and Metamorphic rocks, plus Mineralogy and Crystallography (including minerals of major groups of rocks and sediments).

⁷ At least 30% of the minimum figure must be at Level 2 or higher.

⁸ Minimum figures. Some flexibility in these figures between Level 2 and Levels 3 and M will be accepted. Can include cognate courses in related sciences for some degree schemes.