Oxford Cambridge and RSA

GCE AS Level

Geology

H014

OCR Report to Centres June 2018

About this Examiner Report to Centres

This report on the 2018 Summer assessments aims to highlight:

- areas where students were more successful
- main areas where students may need additional support and some reflection
- points of advice for future examinations

It is intended to be constructive and informative and to promote better understanding of the specification content, of the operation of the scheme of assessment and of the application of assessment criteria.

Reports should be read in conjunction with the published question papers and mark schemes for the examination.

The report also includes links and brief information on:

- A reminder of our **post-results services** including **reviews of results**
- Link to **grade boundaries**
- **Further support that you can expect from OCR**, such as our Active Results service and CPD programme

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GCE AS Level Geology (H014)

OCR REPORT TO CENTRES

H014/01 Fundamentals of Geology

1. General Comments:

Despite this being the first time the new AS, specification has been examined and the relatively small number of candidates there were many several excellent answers seen and in general, candidates expressed themselves well. The new specification highlights opportunities for the introduction of the key mathematical and practical requirements, which are now embedded in the delivery of the specification and assessed in the question papers. The mathematical skills required are clearly explained in Appendix 5e of the specification, and further support is provided by the Mathematical Skills Handbook, available on the OCR website. Those candidates who had been more prepared for the increased emphasis on mathematical content were able to demonstrate their skills. This was also true of candidates who were more prepared for the embedded practical requirements by drawing on experience gained from carrying out practical work both in the laboratory and the field.

Most candidates focussed their answers on the command words and did not just, for example, describe when the question required explanation. However, a significant number of candidates did not follow all the command instructions so tended to be more limited in their answers.

These lower ability candidates wrote under-developed answers, did not address the question clearly, and used non-scientific terms. However, the stronger candidates had a clear grasp of the questions, developed their answers using the correct scientific terminology, and used precise supporting data where appropriate.

Questions marked by Level of Response (LoR) feature in this paper. These questions are marked in a holistic way, rather than matching specific points from the mark scheme. The list of indicative scientific content does not represent an exhaustive list. Responses are expected to deal with all aspects of the question in order to reach the highest level. Examiners are looking for clear scientific points to be made that will be relevant and cover the question that has been asked. In order to achieve the higher mark in the Level, scientific language should be of a suitable standard and ideas should be conveyed with order and clarity. Candidates did find it difficult to access high marks in the new style six mark LoR questions.

Also introduced in this paper are multiple-choice questions (MCQs). Candidates had no difficulty accessing this style of question.

Candidates used their time well and there was little evidence of them running out of time.

The provision of an additional page for continued answers at the back on the paper should be used rather than the inclusion of additional separate answer booklets, often comprising several pages, often for a few extra words.

2. Comments on Individual Questions:

Section A

The inclusion of MCQs is a new feature for the AS and A Level Geology papers. Candidates should expect that during the 20 questions the whole of the specification may be covered.

There were very few missed questions with candidates realising that even a guess could gain them a mark. Candidates should be aware that the answers should be written clearly, without ambiguity with only one letter written. If they change their minds about an answer then it should be clearly crossed out and the intended answer written next to it. When letters are altered, the candidate's intention is frequently unclear and if there is doubt then the mark is not credited.

The questions varied from straightforward recall to those requiring analysis and deduction, with some requiring the use of mathematical skills or relying on the experience gained from carrying out practical work. As this section covered such a range of content and skills, it was no surprise that it achieved a good spread of marks.

Question No. 1

This was answered well with most recognising the amygdaloidal texture although some did not notice the infilling crystals and so opted for vesicular.

Question No. 2

Candidates found this question challenging, not being familiar with the physical properties of the mineral pyroxene, which is a framework silicate (2.1.1b). Using on specification knowledge candidates should have been able to discount the distractors A and B, and deduce that D was a distractor as chain silicates have good cleavage. The specification does not require candidates to memorise the detailed characteristics of multiple minerals (2.1.1c). However, candidates are expected to understand how the crystalline structure relates to the diagnostic physical properties of seven minerals. This can be tested and practised during practical's such as PAG 1.

Question No. 3

Almost every candidate knew that Mohs produced a hardness scale.

Question No. 4

This was answered well by most candidates and showed good recall of the location of the Gutenberg discontinuity.

Question No. 5

Half the candidates knew that the changes in the magnetic field were an indicator of the fluid state of the outer core. Candidates do need to know both direct and indirect evidence for the state and composition of the various layers of the Earth.

Question No. 6

Candidates found it challenging to recognise that sinuous burrows on a bedding plane are most likely to be feeding structures and not for dwelling or protection. Candidates need to be able to recognise how the shape and patterns of trace fossils provides evidence of the behaviour of the organism that formed them. As well as knowing how and in what environment trace fossils were formed.

Question No. 7

A majority of candidates knew that graptolites are extinct and that bivalves, brachiopods and corals are extant. Candidates do need to know the numerical time range of the main fossil groups.

Question No. 8

Working out the flow diagram was quite a challenging task however; the majority of candidates could make logical connections through the rock cycle and so gain the mark. Candidates need to know the processes and products associated with the rock cycle and be confident in the use of the technical terms involved.

Question No. 9

Candidates needed to think about the development of ideas about uniformitarianism, how these related to the timeline of plate tectonic theory and where James Hutton fitted into the combined timeline. Some candidates found it difficult to apply their knowledge from two different parts of the specification synoptically. The recognition that subduction was recognised as a process in the 1960s long after the death of Hutton in the 1790s allows candidates to deduce the correct answer.

Question No. 10

Most candidates recognised the drawing of inverted graded bedding. Other candidates had annotated their question paper and used a process of elimination to rule out the three distractors and deduce the correct answer.

Question No. 11

Candidates find dip and true dip a difficult concept and so struggled with this question. It is important to be able to understand the ideas about dip and strike as theoretical concepts and as physical concepts that can be measured during fieldwork. When candidates can visualise the differences in three dimensions then they will understand these concepts.

Question No. 12

Candidates are expected to know the Goldschmidt classification of elements into four geochemical groups. The siderophile elements are ’iron loving‘ and their preferred state in geological systems is combined with iron. Iron and nickel, the most important siderophile elements, were partitioned into the core during the differentiation of the early Earth.

Question No. 13

Around half of the candidates used the information to calculate the correct focal depth. This question assessed mathematical skills and was an application of the Pythagorean Theorem. Candidates are expected to apply prior knowledge from GCSE Mathematics with other mathematical skills indicated in the specification Appendix 5e.

Question No. 14

Candidates found this question on earthquake mechanisms challenging. The correct response was ‘incorrect’ because it referred to stored elastic ‘stress’ energy rather than elastic ‘strain’ energy: this is a common misconception.. We limit the number of negative MCQ in question papers and never use double negatives. However, negative MCQs are useful for assessing a deeper level of understanding by candidates.

Question No. 15

Most candidates knew that shear stress at transform margins produces strike-slip faults. Candidates are expected to understand the stresses involved at each of the three main types of plate margin and the types of fault that result from these stress regimes.

Question No. 16

Most candidates were able to locate the position of the spreading ridge. .They were looking for a line of symmetry on the map, which only occurred at one position.

Question No. 17

This question asked candidates to identify the three techniques that would show a mantle plume and identify the technique that would not, something that many candidates found challenging. Seismic tomography, and gravity surveys would all show upwelling less dense, hotter material while the electromagnetic survey would show a zone of lower resistivity in the upper mantle resulting from more conductive pathways through the zone of partial melting. Only the magnetic survey would not provide any evidence of a mantle plume.

Question No. 18

Most candidates were able to identify that seismogram A was recorded furthest from the focus. In seismogram B the S wave and L wave arrival time can be seen, while D and C show an increasing delay between the P wave and S wave first arrival. For seismogram A, the delay in S wave arrival time is greatest and off the right-hand scale of the seismogram.

Question No. 19

Candidates can find the concepts of Bouger and Free Air gravity anomalies difficult and this proved to be the case with this question. In a Bouger gravity profile the effect of topography has been removed while for a Free Air gravity profile is reduced to a common elevation (for example sea level). A descending (mafic and dense) lithospheric slab will add extra mass to the rock column and will not be in equilibrium and this creates a positive Bouger gravity anomaly. Mountain chains are usually under isostatic equilibrium and show a positive Free Air anomaly but no Bouger anomaly. Areas undergoing isostatic uplift and over mantle upwelling display negative gravity anomalies as the mass of the underlying rock is lower than expected.

Question No. 20

This was the first of the practical skills questions. . It was looking for an 'incorrect' answer when discussing precision, repeats and uncertainty. All the reformed science GCSE, AS and A Level qualifications follow the guidance contained in the ASE (2010) The Language of Measurement, a summary of this document is available online www.gettingpractical.org.uk/documents/LoMsampleJan2010.pdf and candidates need to be confident in using these terms correctly.

Section B

Question No. 21

This whole question tests the candidates' knowledge of scientific method, reporting and some aspects of mathematics. Skills that may have previously been tested in evaluative and centre based tasks from the legacy specification, are now within the body of the AS examination.

(a)(i) Candidates struggled to work out the mean density and some reported their answer to an inappropriate number of decimal places. There is guidance provided on the use of significant figures and decimal places in the Mathematical Skills Handbook (www.ocr.org.uk/Images/415099-maths-skills-handbook.pdf). The scientific convention is to record the mean of several observations to the same or at most one more decimal place than the raw data.

(a)(ii) Many candidates found it difficult to convert their answer in Q1(a)(i) from g cm^{-3} to kg m^{-3}. Candidates are expected to be able to convert from one unit into other SI units as indicated in Appendix 5e of the specification. These skills are assumed prior knowledge from GCSE science and mathematics. It can assist candidates in keeping these skills fresh to identify opportunities during teaching and learning for candidates to practice using SI units and converting from one to another in geological contexts.

(b) There were two aspects to this question: identifying the igneous rock type from a description of the minerals proportions (dark versus grey) and the grain size. This proved quite difficult for many candidates. Higher ability candidates recognised the rock as being mafic or intermediate and that it was coarse grained; gabbro or diorite were acceptable answers. Candidates were more confident in linking the coarse grain size to the magma having cooled slowly in a batholith.

(c) The concept of percentage difference proved very difficult for candidates to grasp and apply to the data provided. This involved calculating the density of Rock A and Rock B for both students and then calculating the percentage difference between the students' results. Many candidates did not report their answer to three significant figures, which should have been familiar from GCSE science and mathematics. Marks for showing working were gained by some. The Mathematical Skills Handbook for Geology provides useful guidance on the use of ratios, fractions and percentages (www.ocr.org.uk/Images/415099-maths-skills-handbook.pdf).

(d) Most candidates understood that after every repeat the rock appeared denser because pore spaces were filling with water. To gain all three marks candidates needed to explain that the first measurement was taken with no water in the rock sample, and that water is denser than air, or that the water displaced the air. It is this detail of understanding that was often lacking in the responses written by candidates. It can help candidates to develop their examination technique if they understand that the answer space provided and the marks available indicate to them how much detail they should write in their response.

(e) Most candidates knew that repeating the experiment would provide more precise results. More able candidates also discussed either calibrating the balance or using a balance with a higher resolution (for example two d.p.).

(f) Understanding why there would be variation in results (not related to experimental errors) proved a difficult task. Geology candidates should be aware from their experience of fieldwork that there is a natural variation between rock specimens even when taken from the same outcrop. . These include natural variation in mineralogy, porosity, amount of recrystallisation, jointing or weathering and all of these could affect these results.

(g)(i) Most candidates could recognise rhyolite (pumice) from the description given. Candidates need to be able to recognise igneous rocks from field descriptions as well as photomicrographs or geochemical analysis.

(g)(ii) This was the first opportunity for candidates to attempt a six mark LoR question. In this case, t candidates were asked to link together knowledge and apply it to predicting volcanic eruptions using geophysical and other surface measurements. Many candidates knew about volcano prediction methods and so could access various levels of mark. There are three levels and the level credited to a candidate is based on the scientific content in their answer, in this case related to volcano prediction. The position within the level is based on the candidate's ability to communicate in a clear, coherent and logical manner. Many candidates were able to access Level 2 and either 3 or 4 marks depending on their ability to communicate geological ideas. Candidates did not need to write long essays and concise and focussed answers could still gain full marks.

Question No. 22

(a)(i) Most candidates knew that shadow zones were parts of the Earth surface that cannot receive seismic waves.

(a)(ii) Although many candidates knew about the P wave shadow zone they had difficulty explaining why it exists. Candidates needed to discuss velocity change linked to changing physical properties of the rocks such as incompressibility and then explain that this change in velocity refracts the waves inwards. This is the detail expected for 2 marks.

(a)(iii) Not as many candidates as expected knew that the increase in seismic velocities at 5100km (Lehman discontinuity) was due to P waves moving from the liquid outer core to the solid inner core. Candidates must know the state, composition and depth of the main layers of the Earth.

(b)(i) Candidates were not required to recall any information and needed to apply the formula for the volume of a sphere (which was given) to work out the proportion of the Earth's volume taken up by the core. This is a GCSE Mathematics skill expected of AS science candidates but only a minority achieved full marks.

(b)(ii) Candidates struggled with the use of the whole Earth density and surface density values that were given. Many candidates understood the general concept of the core being denser than the value for the whole Earth and that the high density of the core balances out the low density of the crustal rocks. However, fewer candidates achieved full marks by using the values given in the stem of the question to exemplify their understanding.

(c) This was the second six mark LoR question. A description and explanation of the evidence for the rheid nature of the asthenosphere gave candidates an opportunity to gain six marks by demonstrating the application of their geological understanding. This question was marked using the same principles as Q21(g)(ii). This LoR question proved more challenging as candidates were asked to describe and evaluate. Many candidates knew about the seismic waves slowing down (LVZ) without always knowing why and other types of evidence such as gravity anomalies or isostasy were rarely mentioned. Many candidates did attempt to link the moving asthenosphere to the older ideas of convection currents driving plate movement rather than as a ductile weak zone that allowed the movement of the rigid lithospheric plates under the influence of slab pull. Most candidate answers lacked an appropriate amount of detail and did not draw clear lines of reasoning between the evidence and the effects demonstrated through plate tectonic processes.

Question No. 23

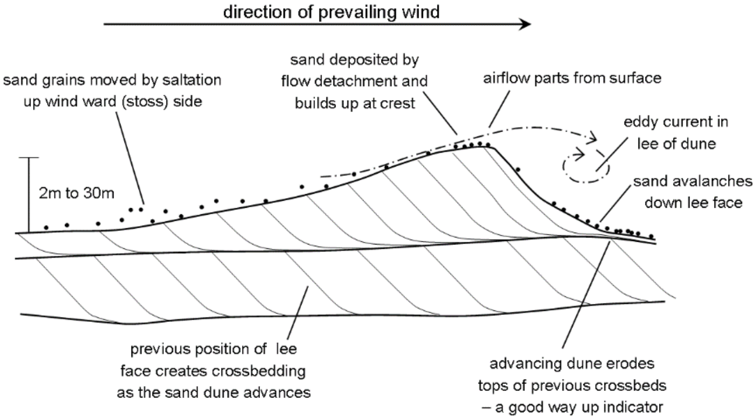
(a)(i) Candidates were very confident in describing and measuring these two sedimentary rocks. The correct terminology was used by most candidates; in particular, descriptions of grain shape and sorting used standard terminology. Candidates should give a numerical value for grain size such as 0.25 mm rather than use the more vague terms such a medium grained. .

(a)(ii) There were many possible sedimentary environments where a poorly sorted, angular sand could form and most candidates knew one such as glacial, wadi, river or abyssal plain.

(b) Although candidates had a reasonable understanding of compositional and textural maturity of sediments they could not fully explain how and why this maturity varies. Candidates were expected to discuss the mineralogy (compositional maturity) of sediments linked to transport and the physical properties of the minerals. Candidates were better at explaining the link between transport (including attrition and abrasion) on grain shape (textural maturity). This was a 4 mark question and so required greater depth of understanding and explanation rather than a repeated description based on the text of the original question.

(c)(i) The majority of candidates knew that large-scale cross bedding forms in deserts, more specifically large-scale sand dunes.

(c)(ii) Candidates struggled to draw accurate and well labelled cross sections of dunes that also indicated the processes that formed the cross bedding. The annotated cross section shown in the published mark scheme is an excellent exemplar of the level of detail that candidates should strive for (see below). Candidates had generalised ideas of the processes but detail on how processes formed large-scale cross bedding was lacking.



(d)(i) Many candidates knew enough about the formation of desiccation cracks to gain 1 mark but lacked the detail required to gain 2. Most candidates described the drying out of mud. Better answers mentioned the mud contracting and cracking or linked the cracks to a specific environment such as a playa lake or area of abundant evaporation.

(d)(ii) Candidates needed to make the connection between the desiccation cracks and the properties of muddy sediments. The mudstone bed at the base of the sedimentary log contains the clay minerals, and these minerals shrink, as water is lost from the muddy sediments. About one third of candidates made this connection. Candidates are expected to apply their knowledge and understanding of the full AS course to understanding and interpreting sedimentary logs. This includes the overall environment of deposition and also recognising sedimentary rock types and structures.

(e) Candidates were expected to recognise that the sequence of rocks in the sedimentary log were from a desert environment with playa lake, dune and also wadi deposits. In this case, the coarse grained rock with pebbles is from flash flood deposits in a wadi. Candidates can then explain the texture most successfully by linking the poor sorting to being rapidly deposited as the peak flow of the flood rapidly waned and its capacity to transport sediment dropped.

Question No. 24

(a)(i) Candidates were expected to analyse the cross section showing two igneous features and be able to deduce that because igneous rock J had vesicles then it must be a lava flow or extrusive. About a third of candidates could make the link. This should be a fairly straight forward piece of deduction. In particular, the diagram is looking at the similarities and differences between sills and lava flows, which is a topic that candidates should understand in detail.

(a)(ii) The vast majority of candidates recognised the bubbles as vesicles and most could offer a partial explanation for their formation. Higher ability candidates linked vesicle formation to a drop in pressure leading to the exsolution of the gases, which rose under buoyancy towards the surface of the lava flow before they became trapped by the solidifying rock.

(b)(i) If candidates fully understood the differences between sills and lava flows in the field then they should be aware that K has no vesicles because it is intrusive and so the pressure had not dropped. The reddened surface indicated chemical weathering at the surface, which could only happen in the extruded lava. Hence, a detailed understanding and logical explanation was required to gain both marks. Candidates must not just be able to describe the differences between a sill and a lava flow but understand and be able to explain why these differences exist.

(b)(ii) Most candidates were able to explain why the differences in crystal size varied from the edge of the intrusion to the centre. Better answers linked the interior of the sill being more insulated while the rate of cooling by heat lost to the country rock at the chilled margins. This variable rate of cooling was then linked to crystal size, using terms such as finer and coarser crystals/grained.

(c) Candidates had more difficulty explaining the changes that took place in the baked margin. The descriptions needed to be about observable differences that would be seen in the field such as colour change or an increase in hardness. The explanation needed to focus on the heat of the intrusion causing (contact) metamorphism or recrystallisation of the country rock. Many candidates did not make the link between the changes in the country rock at the contact margins and the process of contact metamorphism.

Question No. 25

(a)(i) In the past candidates frequently struggled with any question on metamorphic geology. It was encouraging to see how candidates responded to the splitting of metamorphic petrology between H014 and H414. Contours of equal metamorphic grade delineate areas on the map using the principle that each contour is drawn enclosing the first appearance of successive minerals from the next metamorphic grade on a map. Candidates were not expected to know details of the P–T stability fields of minerals shown or the rigorous criteria for constructing isograds; which is A Level only content. However over half of all candidates achieved full marks for this higher demand practical skills question and most candidates drew at least two correct contours.

(a)(ii) Candidates are expected to understand the concept of metamorphic grade and index minerals. Many struggled to provide a definition of index minerals and explain how the first appearance of an index mineral is significant in the drawing of contours of equal metamorphic grade on a map. A useful teaching strategy is to use metamorphic grade as an application of candidates' prior learning on sets and Venn diagrams from KS3 Mathematics.

(a)(iii) Most candidates deduced from the pattern of contours they had drawn that index mineral L in the East (ie sillimanite) represented the highest grade, and inferred that as the metamorphism of the shales was caused by the granites then the granite intrusions should be in the East. This question assessed the ability of candidates to interpret data and no prior knowledge of specific metamorphic minerals was assumed or required.

Question No. 26

(a)(i) Candidates are expected to be able to explain the formation of magma at convergent and divergent plate margins and hot spots. This can be linked to increased temperatures, increased water content or decreased pressure. In this case, candidates needed to discuss the drop in pressure causing partial melting linked to the solidus/melting point in the mantle. Candidates should also discuss passive upwelling of the mantle (but not magma) in response to the diverging plates (by processes such as ridge push). This detail was often lacking from candidate answers. Instead, many candidates discussed pre-1970s ideas of magma rising up through the mantle aided by convection currents. The current consensus theory, based on persuasive geophysical evidence is that magma forms by partial melting just above or below the crust/mantle boundary (see https://teacheratseablog.wordpress.com/2017/04/17/a-level-geology/).

(a)(ii) Candidates struggled to demonstrate an appreciation of the value of ophiolites in our understanding of plate tectonics. Candidates should be aware that ophiolites provide geologists with a view of a cross section of oceanic crust exposed on land, when ordinarily this would be hidden kilometres down beneath the abyssal plains of the ocean. Candidates should also know that obduction is the mechanism that brings ophiolites onto land. Close inspection of ophiolites can then give an insight into the structure and formation of oceanic crust at divergent margins.

(b)(i) Candidates were confident and proficient in their plotting of the data points.

(b)(ii) Most candidates realised that the majority of the Troodos data points were outside the MOR field and in the subduction zone/island; arc zones and so did not form at a MOR.

(b)(iii) The majority of candidates found it a straight forward task to calculate the percentage of the new ophiolites data points within the island arc and the mid-ocean ridge data fields.

(b)(iv) This five mark extended response question required candidates to carry out a detailed evaluation of the plotted data and then apply this evaluation using known concepts in an unfamiliar context. In the previous specification, these skills would have been assessed in the coursework tasks. The practical skills in modules 1.1.1 to 1.1.4 are now assessed in the written examination and not all candidates appeared to have been well prepared for this new approach. Candidates needed to look for and describe patterns and correlations within the data as well as attempting to explain the patterns observed. Most candidates did reasonably well at identifying patterns and correlations but struggled when asked to evaluate. It is important for candidates to appreciate that when asked to apply their understanding in unfamiliar contexts they are not expected to provide the ‘right answer’ but rather apply their geological knowledge and understanding in a scientific way to suggest appropriate answers that are supported by the data.

Question No. 27

(a)(i) Being able to visualise the vertical movement of a fault based on a geological map is a complex spatial skill that candidates will need to practice to master. Visualising of geological maps, folds and faults in three dimensions are skills that must be developed over time in class and, as importantly, by experiencing real examples for themselves in the field. A significant number of candidates were able to work out the three dimensional structures shown on the map but many others struggled with the concept of visualisation.

(a)(ii) Once visualised it was a reasonably straightforward step to work out that the structure formed between the two faults was a graben. Error carried forward (ecf) was allowed if the candidate had reversed the downthrown on the faults so as to indicate a horst.

(b)(i) Drawing cross sections of simple geological maps is new to the specification and is a skill that takes time to develop and was clearly not straightforward for most candidates. Candidates should practice constructing cross sections so that they can draw the correct fold structures, maintain bed thickness across the structure and show the correct sense of movement along the faults. Once candidates can do this then it will help greatly in their visualisation of geological structures in three dimensions such as required in Q27(a)(i).

(b)(ii) Most candidates recognised the unconformable relationship between the Triassic conglomerate and underlying Carboniferous rocks. However, many struggled to put the evidence for this relationship shown on the map into appropriate technical language. Many candidates used terms such as ‘overlapping’ or ‘overlaying’ with only vague explanations and it was unclear whether they understood these technical terms. The best answers used ideas about different dip amounts and/or directions above and below the unconformity, or the idea of the plane of the unconformity cutting across the older beds and structures. It is better for candidates to use familiar technical language well rather than trying to use advanced terminology (such as overlapping) poorly.

(b)(iii) Most candidates knew that tensional forces were the most likely cause of graben structures.

(b)(iv) A majority of candidates knew that folds are created by compressive forces.

(b)(v) Some candidates found it hard to reconcile the paradox of two different stress regimes affecting the same area. Many candidates deduced that there must have been a time gap between the two different forces operating.

(c) Candidates are usually very good at describing fold structures in cross section and this proved the case with this question. The majority of candidates described the fold as an asymmetrical antiform/anticline. Stronger candidates described it as plunging or open or described the amount and direction of dip of the two limbs.

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