

## Paper 1 Physical Core

### UNIT 3 Rocks and weathering

**Recommended Prior Knowledge** The fundamental principles of tectonics and weathering may have been introduced at IGSC. However no previous knowledge is essential to this unit.

**Context** Weathering processes are influenced by climatic factors and there is a close relationship between fluvial processes and slope processes. Therefore there are clear links between all three units within the Physical Core.

**Outline** This unit covers basic principles of tectonic activity and weathering and slope processes. Although the human impact is designated as a sub-unit, it seems advisable to include human activities as a factor influencing weathering and slope processes rather than teaching it separately.

Content	Objectives	Terminology	Teaching Strategies (TS) and Activities (A)	Resources
3.1 Elementary plate tectonics	<ul style="list-style-type: none"> <li>Knowledge of global distribution of lithospheric plates</li> <li>Knowledge of different types of plate boundary</li> </ul>	<p><b>Crust, mantle, core</b> <b>Lithosphere</b> <b>Asthenosphere</b></p> <p><b>Divergent/constructive margins</b> <b>Convergent/destructive margins</b></p> <p><b>Convection currents</b> <b>Ridge push</b> <b>Slab pull</b> <b>Sea floor spreading</b></p>	<p><b>TS</b> Begin with basic structure of the earth. Then a map of global distribution of plates – describe - linear on continental margins/coastal, i.e. <b>not random or scattered</b>. The map could be annotated. Emphasise the idea of <b>pattern</b> globally.</p> <p><b>Define a tectonic plate</b> - two key points - it is a slab of lithosphere and it moves.</p> <p><b>Explain reasons for movement</b> - convection currents in the mantle. Brief reference to evidence that plate movement has occurred in the past – use of atlas maps, especially the S. America /Africa “fit”. (Be careful not to launch into a long discussion about ‘continental drift’).</p>	<p><b>Maps</b> Waugh p.10 fig.1.2 Guinness and Nagle p.93 Fig. 4.1 and 4.2 Nagle p.8 Fig 1.7 Prosser pp.10-11 Fig 1.5 Hart p.86 fig. 4.2 Ross p.29 fig.2.4 Guinness and Nagle p.95 Fig 4.5</p> <p>Ross p.30 fig.2.9</p> <p>Geofile 554 Plate boundaries Himalayas and Pacific USA. <b>June 2008 Q. 8(b)</b> Sea floor spreading.</p>

	<ul style="list-style-type: none"> <li>Knowledge and understanding of the processes and landforms associated with each type of boundary</li> </ul>	<p> <b>Island arcs</b>  <b>Subduction zones</b>  <b>Ocean trenches</b>  <b>Benioff zones</b>  <b>Transform faults</b>  <b>Seismic activity</b>  <b>Volcanic activity</b>  <b>Shallow/deep focus earthquakes</b>  <b>Fold mountains</b>  <b>Mid-ocean ridges</b> </p> <p> <b>Conservative margins</b>  <b>Collision zones</b> </p>	<p><b>TS Consider each plate boundary.</b> Describe and explain processes. Consider landforms associated with each type of boundary/margin. Diagrams are the best way of keeping the material manageable and easy to understand.</p> <p>Students should see how the two major types of margin are complementary, i.e. ridge push and slab pull balance each other out, so that the crust does not become progressively larger. Idea of a system once more.</p> <p>Rates of movement equivalent to the growth of a finger nail.</p> <p>This part of the unit could, and probably should, be illustrated by reference to specific plate boundaries. e.g. Nazca-South American plate, mid-Atlantic ridge, Pacific-Eurasian-Philippine (island arcs/trenches)</p> <p>San Andreas Fault. Although not specified, conservative margins and collision zones can be useful additions to this section, but will not be examined. (Content will be useful for Hazardous environments in Paper 2.)</p>	<p>Nagle pp.9-10 Prosser pp.12-3 Hart pp.88-94</p> <p>Ross pp.31-37, pp.38-48</p> <p>Case Study of East African Rift Prosser p.17 <b>June 2006 Q. 8(b)</b> Fold mountains <b>June 2004 Q. 3</b> Ocean ridges. Useful map good teaching tool.</p> <p>Guinness and Nagle p.311, fig 9.12 Geofile 526 Sept 2006 Hot spots in Plate Tectonics Prosser p.15 Himalayas p.16 San Andreas Fault Ross p.37 Fig 2.18 Nagle p.22</p> <p><b>Nov 2006 Q. 8(c)</b> Relationships between plate boundaries and landforms <b>June 2007 Q. 8(c)</b></p>
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<p><b>3.2 Weathering and rocks</b></p>	<ul style="list-style-type: none"> <li>Knowledge and understanding of major physical and chemical weathering processes</li> <li>Appreciation of the role of biological agents in weathering processes</li> <li>Related end products of the processes</li> </ul>	<p><b>Freeze-thaw action/Frost shattering</b>  <b>Exfoliation</b>  <b>Wetting/drying</b>  <b>Spheroidal weathering</b>  <b>Dilatation</b>  <b>Salt crystallisation</b>  <b>Hydration</b>  <b>Hydrolysis</b>  <b>Carbonation</b>  <b>Solution</b>  <b>Oxidation</b></p> <p><b>Chelation</b>  <b>Humic acid</b></p> <p><b>Effects of acid rain</b></p> <p><b>Granular disintegration</b>  <b>Block disintegration</b></p>	<p><b>TS</b> Introduce the classification of weathering processes. <b>Define weathering</b>-‘breakdown of rocks in situ (where they are)’. Emphasise the idea that no transport is involved. Also the importance of moisture being present. Can go on to develop the idea of <b>erosion</b> and then <b>denudation</b> so that students see the processes in context. Use annotated diagrams where possible. Photographs can help hugely in explaining how the processes operate. Photographs from past question papers can be a useful tool.</p> <p><b>A</b> Can be reinforced by a matching exercise – process and description – a simple but often effective means of generating discussion and encouraging thought about the processes, especially when produced on slips of paper which can be physically rearranged and classified into sets representing physical/chemical/weathering/erosion.</p> <p>Discuss whether biological agents justify a separate category of weathering or whether these agents carry out physical/chemical processes, e.g. tree roots, humic acids, organisms, etc.</p> <p>Can introduce the human impact here and discuss increased carbonation - solution on buildings, etc. to cover part of 3.4</p> <p>End products should be linked. (This is important because it is often forgotten by candidates). Therefore physical weathering tends to produce block disintegration, and chemical weathering, granular disintegration.</p>	<p>Ross pp.49-52          Waugh pp.40-43          Hart pp.95-98          Prosser p.26          Nagle pp.30-32</p> <p>See <a href="http://regolith.com">regolith.com</a> for photographs of landforms</p> <p>Ross p.49 Fig 2.37</p> <p>Prosser - Very good on weathering rates pp.29-30</p>
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	<ul style="list-style-type: none"> <li>• Knowledge and understanding of the factors which influence weathering processes</li> <li>• A detailed appreciation of the role of climate as a factor</li> </ul> <ul style="list-style-type: none"> <li>• Properties of two rocks - granite and limestone</li> </ul> <p>Resultant landforms are not required here, see Paper 2 Tropical environments for them.</p>	<p><b>Joints Bedding planes Composition Structure</b></p>	<p><b>TS</b> Introduce the ways in which factors such as climate, vegetation, soils, rock lithology, relief and time may influence weathering processes. Fundamentally, climate and rock lithology are the two key factors. Climate plays an overarching role because it influences other factors like vegetation and soils.</p> <p><b>A Peltier diagram</b> should form the basis for class discussion and then questions can be set on it. Can be annotated with processes. This diagram often forms the basis of examination questions. Candidates are not required to be able to draw it from memory.</p> <p><b>Latitudinal variation of regolith depth illustrates role of climate in weathering processes and can be related to the areas on the Peltier diagram.</b></p> <p><b>TS</b> First, the <b>characteristics</b> of granite and limestone. <b>Processes</b> that influence them. Granite -hydrolysis,limestone – carbonation and solution. Introduction of the idea of contrasts between weathering in the tropics and temperate latitudes could be included especially as a preparation for the Paper 2 Tropical environments option, if this is to be studied. However it is not essential for this unit.</p> <p>Impact of human activity in areas like the Yorkshire Dales, UK would provide material for the human impact on weathering and mass movement here.</p>	<p>Ross p.53 Fig.2.42 Ross p.55 Fig.2.44* Hart pp.98-100 Waugh p.44 Fig 2.10 Nagle pp.32-3</p> <p><b>Nov 2006 Fig. 3 and June 2008 Figs 3A and B.</b> Very useful teaching tools. Basis of the whole discussion about the role of climate in weathering types and rates.</p> <p><b>Nov 2005 Fig. 2</b> Essential and excellent teaching tool.</p> <p><b>June 2007 Q.8(b)</b> specifically on granite</p> <p>Hart pp.104-5 Prosser p.27</p> <p>Nagle pp.40-1</p> <p>Hart pp.100-2 Nagle pp.34-5, pp.38-9 Prosser p.29 Ross pp.71-75</p>
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<p><b>3.3 Slope processes and development</b></p>	<ul style="list-style-type: none"> <li>• Understand that slopes are systems</li> <li>• Knowledge of slope form</li>   <li>• Understanding of mass movement</li>   <li>• Knowledge and understanding of processes of mass movement</li>   <li>• Understanding of the relationship between process and form</li>   <li>• Knowledge and understanding of</li> </ul>	<p><b>Internal strength</b>  <b>Shear stress</b>  <b>Boulder controlled slopes</b>  <b>Concave slope</b>  <b>Convex slope</b>  <b>Free face</b></p> <p><b>Heave</b>  <b>Flow</b>  <b>Fall</b>  <b>Slide</b>  <b>slump</b>  <b>Soil creep</b>  <b>Landslide</b>  <b>Mudslide</b>  <b>Avalanche</b>  <b>Rotational slip</b>  <b>Debris slide</b>  <b>Debris avalanche</b></p>	<p>Footpath erosion, removal of clints from limestone pavements for landscape gardening, may be useful additions for 3.4</p> <p><b>TS</b> Introduce using a diagram of the slope as a system with inputs and outputs. Consequent form is dynamic, as the result of processes. Look at relationship between internal strength and external forces producing shear stress. If stress greater than strength, then movement occurs.</p> <p><b>Critical angle of rest for different particle sizes/shapes.</b> Result and slope form.</p> <ul style="list-style-type: none"> <li>• Definition of mass movement 'Movement of material downslope <b>under the influence of gravity</b>'. There is no other agent of movement, but slope wash and/or the presence of soil water may assist the process. Understanding of the role of water</li> </ul> <p>Classification of slope processes - a triangular diagram is the best way of discussing the variety of processes. Conditions for each type of process.</p> <p><b>A</b> The students can then plot some of the processes for themselves to demonstrate their understanding</p> <p>Students need to learn about each of the major processes and be aware of the resultant slope forms. E.g. rotational slip may be a slide along a slip plane with a flow at the toe if there is clay at the base of the slope. So there will be a compound slope profile possible with concave and convex elements</p> <p><b>Note</b> It is important that students realise that differences in slope processes produce differences</p>	<p><b>June 2007 Q. 3 Fig. 3</b> is a model of a slope, ideal teaching tool.</p> <p>Ross p.59  Waugh p.46 Fig 2.12  Prosser p.34 Fig 1.37  Hart p.106 Fig. 4.37  Hart p.107  Nagle p.46  Geofile Jan 2008 Hillslope hydrology</p> <p><b>June 2006 Fig. 2</b> alternative to the triangular diagram, useful teaching aid.</p>
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<p><b>3.4 The human impact</b></p>	<p>the factors that influence slope processes</p> <ul style="list-style-type: none"> <li>Understanding that human activity may have a significant impact on weathering and slope processes</li> </ul>	<p>in slope form. By that is meant angle/gradient, shape, characteristics. Often this answer is one of the weakest on the paper.</p> <p>The factors are similar to those that influence weathering - <b>climate, soil, vegetation, rock lithology</b> especially <b>mixed lithology</b> (e.g. chalk overlying clay).  <b>Gradient</b> (influences the shear stress), <b>aspect</b>. Should be seen as part of the slope as an open system.</p> <p><b>Students should understand the role of climate in influencing rates of weathering.</b> This is usually little appreciated by candidates. Do emphasise and study this part of the topic.</p> <p>Human activities which affect weathering and slope processes may be</p> <ul style="list-style-type: none"> <li><b>intentional</b> (e.g. mining, quarrying, spoil heaps, stabilising slopes, coastal management), or</li> <li><b>unintentional</b> (e.g. effects of acid rain, deforestation, overgrazing by animals, landslides where favelas have been built on steep slopes).</li> </ul> <p>Impacts may be positive, i.e. prevent movement, or</p>	<p><b>Nov 2005 Q. 8(c)</b> and <b>June 2008 Q. 3(b)</b>. The question appears frequently.</p> <p>Hart p.115  Nagle p.49  Waugh p.46 Fig 2.13  Ross p.59  Hart pp.108-113 Detailed catalogue of processes</p> <p>Waugh pp.47-9  Good case studies pp.52-57  Prosser pp.32-38 Very good on how slopes develop  Hart p.114 Case Study of Holbeck Hall, UK  Ross p.58 Good diagrams and explanation</p> <p><b>June 2007 Q. 3(b)</b>  <b>June 2008 Q. 3(c)</b> specifically on rates of weathering</p> <p><b>June 2006 Q. 8(c)</b> emphasis on weathering and slope form</p> <p>Ross pp.59-62 including case study  Nagle pp. 54-55</p> <p>Hart pp.115-7 Good material on human activities</p>
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