AMERICAN UNIVERSITY OF BEIRUT
DEPARTMENT OF GEOLOGY

FINAL EXAMINATION

Geomorphology (Geol 210)	**January 23, 2006**
Dr. Fadi Nader	**8:00 am**
Exam rules apply	**Time: 2 hours**

PART I: Definitions and Short Answers

1. **Define ten out of the <u>twelve</u> following terms (20 points):**
   Stochastic Model – Isostasy – Karren – Warm-based Glaciers – Abrasion – Fetch – Longshore Drift – Spits – Erodibility – Mixed Tides – Horn – Relief.

2. **Short answers (30 points):**
   a. The endogenic processes are usually constructive and they are grouped in the following categories (or types):

   b. List the major morphological features in the oceans and on continents.

   c. Name the major processes of weathering and define one of them.

   d. The Frictional Resistance of slope material is a function of both:

   e. What are the key properties of alluvial channels (in plan view)?

   f. Name the forces that induce the movement and entrainment of sediments in aeolian settings:

   g. Glaciers are composed of ice, and smaller amounts of:

   h. Glacial erosion is accomplished by three major processes; these are:

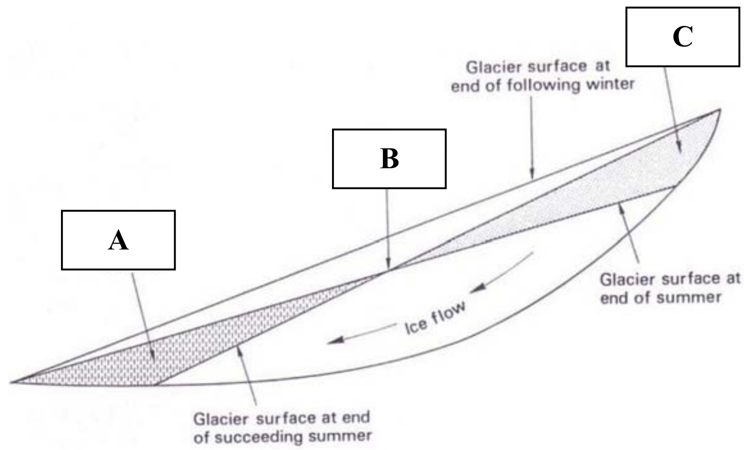
   i. Waves are characterized by their:

   j. <u>A *relative rise of sea level*</u> is an apparent rise in the mean level of the sea surface with respect to a landsurface and can result from:

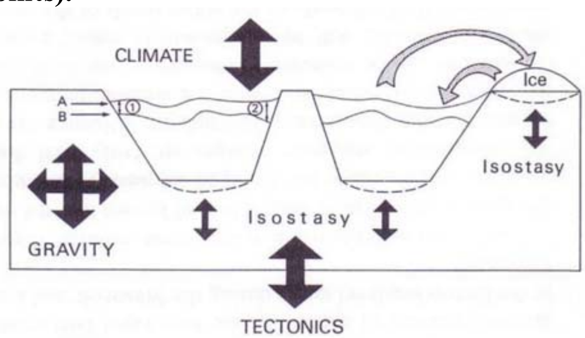
PART II: Diagrams and Short Discussions

3. **Draw the ternary classification of coastal deltas and briefly define the corresponding types of deltas (5 points).**

4. **Give a proper title to the following figure and label it (5 points).**



5. **Give a proper title to the following figure and explain it in less than 10 lines (10 points).**



6. **Give a proper title to the following table (5 points).**

TYPE	FORM AND POSITION	MODE OF DEVELOPMENT
Blowout (A)	Circular rim around depression	Localized deflation
Parabolic dune (B)	'U' or 'V' shape in plan view with arms opening upwind to enclose a blowout	Deposition of sand locally deflated upwind; arms are usually fixed by vegetation
Lunette (C)	Crescent-shaped opening upwind	Accumulation downwind of localized sediment source such as desiccated lake basin or pan
Shrub-coppice dune (nebkha) (D)	Roughly elliptical to irregular in plan, streamlined downwind	Accumulation around and downwind of vegetation clump
Lee dune (E)	Elongated downwind from topographic obstruction	Accumulation on protected lee side of obstacle
Fore dune (E)	Roughly arcuate with arms extending downwind either side of obstruction	Accumulation in zone of disrupted airflow immediately windward of obstacle
Climbing dune (F)	Irregular accumulation rising up windward side of large topographic obstruction	Accumulation in zone of disrupted airflow on windward side of obstacle
Falling dune (F)	Irregular accumulation descending leeward side of large topographic obstruction	Accumulation in zone of disrupted airflow on upwind side of obstacle
Echo dune (F)	Elongated ridge roughly parallel to, and separated from, windward side of topographic obstruction	Accumulation in zone of rotating airflow upwind from large obstacle

PART III: Discussion

7. **Answer one of the two following questions (25points):**

   a. **Discuss the methods of measurement and estimation of present fluvial denudation rates.**
   *** What are the estimates of fluvial denudation rates used for? Justify your answer.**

   The following three tables are intended to help you answer this question:

Table 15.3 Comparison of sediment yields (t km^{-2} a^{-1}) under natural and artificial conditions in various countries

LOCATION	NATURAL	CULTIVATED LAND	BARE SOIL
UK	10–50	10–300	1000–4500
USA	3–300	500–17 000	400–9000
China	<200	15 000–20 000	28 000–36 000
India	50–100	30–2000	1000–2000
Nigeria	50–100	10–3500	300–15 000
Ivory Coast	3–20	10–9000	1000–75 000

Source: Data from R. P. C. Morgan (1986) *Soil Erosion and Conservation*. Longman, London, Table 1.1, p. 5, based on various sources.

Table 15.5 Estimates of total transport by rivers of solids and solutes to the oceans and equivalent estimated denudation rates

AUTHOR	MEAN LOAD (10^9 t a^{-1})	MEAN LOAD (t km^{-2} a^{-1})	EQUIVALENT DENUDATION RATE† (mm ka^{-1})
*Solid load**			*Mechanical*
Fournier (1960)	58.1	392.6	145.4
Jansen and Painter (1974)	26.7	180.4	66.8
Schumm (1963)	20.5	138.5	51.3
Holeman (1968)	18.3	123.6	45.8
Milliman and Meade (1983)	13.5	91.2	33.8
Lopatin (1952)	12.7	85.8	31.8
Solute load			*Chemical‡*
Goldberg (1976)	3.9	26.4	5.9
Livingstone (1963)	3.8	25.7	5.7
Meybeck (1979)	3.7	25.0	5.6
Meybeck (1976)	3.3	22.3	5.0
Alekin and Brazhnikova (1960)	3.2	21.6	4.8

* Suspended load only.
† Denudation rates based on a rock density of 2700 kg m^{-3}.
‡ Rates for chemical denudation assume that 40% of total solute load is from non-denudational sources.

Table 15.4. Average composition of World river water and estimates of denudational and non-denudational contributions for different constituents

	Ca^{2+}	Mg^{2+}	Na^{+}	K^{+}	Cl^{-}	SO_4^{2-}	HCO_3	SiO_2	Total
Average composition of World river water (Concentration (mg 1^{-1}))	13.5	3.6	7.4	1.35	9.6	8.7	52.0	10.4	106.6
Provenance of major solute components (%)									
Non-denudational:									
Precipitation (oceanic salts)	2.5	15	53	14	72	19	-	-	12
Atmospheric CO_2	-	-	-	-	-	-	57	-	28
Denudational:									
Chemical weathering	97.5	85	47	86	28	81	43	100	60

Source: Based largely on data in M. Meybeck (1983) in: *Dissolved Loads of Rivers and Surface Water Quantity Quality Relationships*. International Association of Hydrological Sciences Publication **141**, 173-192.

b. **Sea-level changes have significant impacts on the geomorphology of oceanic islands. Use the following diagrams to discuss and explain the origin and development of oceanic islands landscape and its relationship with sea-level changes.**

The following three figures are intended to help you answer this question:

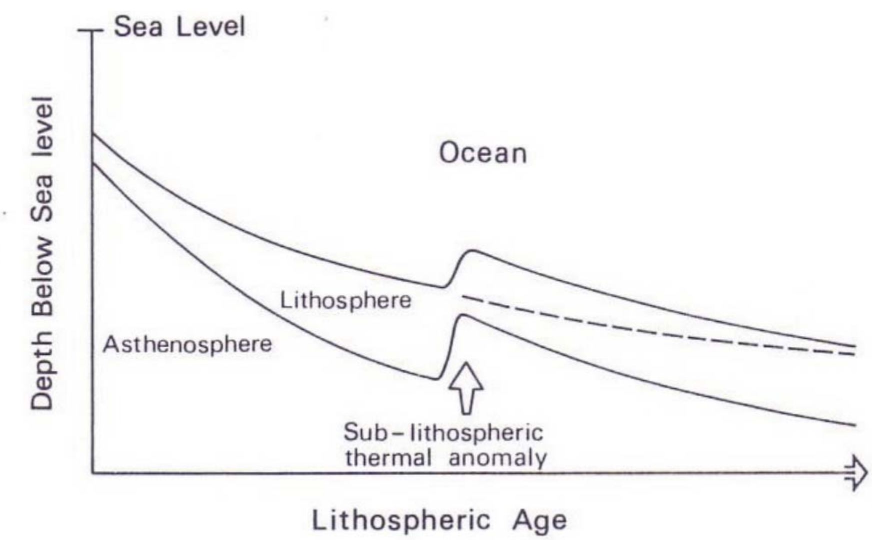


Fig. 17.18 *Changes in the elevation of the ocean floor as a result of heating associated with a sub-lithospheric thermal anomaly. Such a heating anomaly may give rise to a volcano which grows sufficiently to emerge above sea level. (After R. S. Detrick and S. T. Crough (1978)* Journal of Geophysical Research *__83__, Fig. 4(C), p. 1239. Copyright by the American Geophysical Union.)*

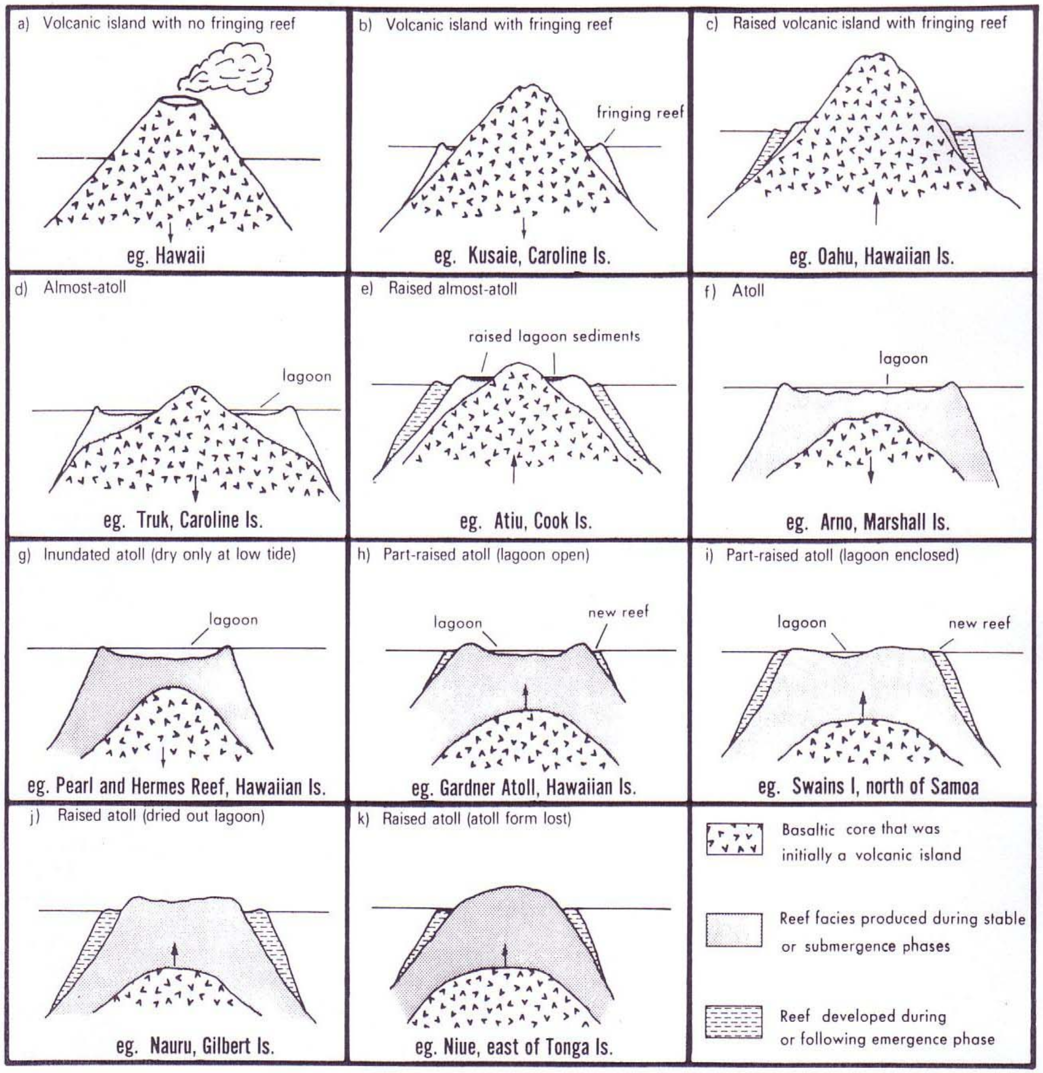


Fig. 17.20 *Types of oceanic island in the Pacific Ocean. Differences between the various types reflect the net effects of volcanism, oceanic lithosphere subsidence and flexure, sub-lithosperic heating and consequential uplift, eustatic sea-level change, coral growth and sub-aerial denudation. (From G. A. J. Scott and G. M. Rotondo (1983)* Coral Reefs ***1****, Fig. 2, p. 141, based largely on H. J. Wiens (1962)* Atoll Environment and Ecology. *Yale University Press, New Haven and O. K. Leont' yev et al. (1975)* USSR Oceanology ***14****, 840–846.)*

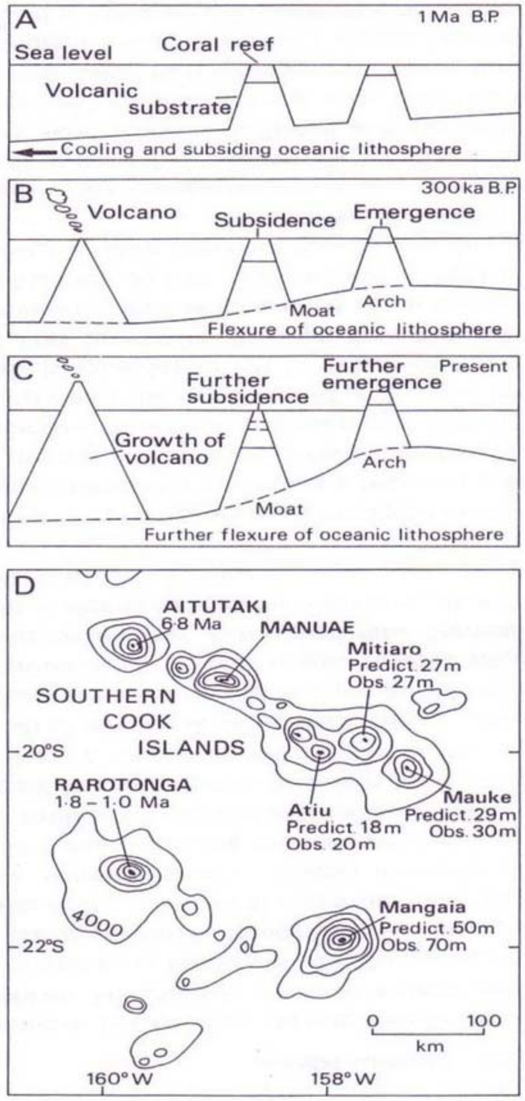


Fig. 17.21 *Relative sea-level change associated with the flexure of the lithosphere as a result of loading by a volcano. (A) The initial situation with coral reefs growing on volcanic substrate subsiding on cooling oceanic lithosphere. (B) The initial effects of lithospheric flexure brought about by the development of a volcano near by with submergence in the 'moat' and emergence on the 'arch'. (C) Further submergence and emergence occurs as the mass of the volcano increases and the flexure of the lithosphere becomes more marked. Note the short time scale of such deformation. (D) The application of a flexural model to the southern Cook Islands in the southern Pacific. Loading has been caused by three volcanoes – Rarotonga, Aitutaki and Manuae – and the predicted uplift for the surrounding islands is compared with the observed uplift. The match is close except for Mangaia which may be within the zone of deformation of a fourth volcano to the south not included in the calculations. (Based on M. McNutt and H. W. Menard (1978)* Journal of Geophysical Research ***83****, Fig. 2, p. 1207 and Fig. 4, p. 1210; and* General Bathymetric Chart of the Oceans, *1984. Canadian Hydrographic Service (bathymetric contours).)*

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