平成15年度（2003年度）
東北大学大学院理学研究科　地学専攻
博士課程前期２年の課程　入試問題

英語

平成14年9月9日　9：00～12：00　実施

注　意　事　項

1. 机の上には受験票、筆記用具、時計以外は置いてはいけません。
2. 合図があるまで問題冊子を開いてはいけません。
3. 試験時間は9：00から12：00までです。
4. 問題はⅠ、Ⅱ、Ⅲの３問です。
   問題Ⅰは受験者全員に共通の問題です。
   問題Ⅱおよび問題Ⅲは、それぞれA、B、Cから１問を選択して解答します。
   Aは地圏進化学・環境動態論分野、Bは環境地理学・環境動態論分野、Cは地球惑星物質科学・比較固体惑星学分野からの出題ですが、希望分野にかかわらず自由に選択して構いません。
5. 解答はすべて解答用紙に記入します。解答は大問１題毎に解答用紙を別にします。解答用紙の所定の欄に受験番号・氏名・希望分野および問題番号を（IIおよびⅢはABCも）明記します。

問題 I-1（共通問題）

次の英文を読み，下記の設問に答えよ．

Global environmental change takes two forms: systemic and cumulative. ① Systemic changes are those that occur in the globally operating systems of the atmosphere and oceans, whereas globally cumulative changes are localized changes that are widely replicated and that in sum constitute change in the whole human environment. Examples of the former include global climate change, and examples of the latter are soil erosion, deforestation, and land degradation. Neither kind of change is a novel phenomenon, as (1) change occurs in nature, and (2) change has taken place throughout human history. What is novel is the ever-increasing intensity and extent of both changes as they are driven by human activities. Since 1700, human impact has taken an apparent leap, and global environmental change since then has increasingly been of human origin.

Global environmental change not only originates largely in human activities, but also exerts increasing effects on the security and well- being of societies. Thus the human dimensions of the change have attracted the attention of the scientific community recently. The concern spreads from causes to (3) of environmental change in a society, i.e., human impacts on the environment, and impacts of environmental change on the society. Researchers group the human dimensions into three major areas: human impact of environmental change, human driving forces, and societal responses to the change. ② In addressing human impact of environment, the concern is no longer that of what in the environment has changed and how much it has changed, but that of how significantly the change has affected society—its well-being, income, production, health, and livelihood. Studies of human driving forces not only identify human contributions to environmental change but also seek to determine how individual forces have interacted with the environment through proximate human activities, as well as how combinations of forces interact with the environmental system. Research on societal responses recognizes human potentials and efforts, or a lack of them, in responding to the environmental changes that have happened; the focus is on how society attempts to slow down and reverse the change in progress. (4) may also invoke further environmental degradation, if the approaches are not appropriate. Again, the human environment relationship is not portrayed as a

static loop but as multiple-route dynamics.

Most assessments of global change have addressed systemic change and have been planetary in scope. Yet a regional approach to the study of global change is essential for understanding both physical changes and their human dimensions. Increasingly it is recognized that global change cannot be adequately addressed without understanding the significant variation in the global average. The spatial variations in the forces, types, and human consequences of environmental change are so large that the usefulness of global-scale (5) is questionable. ③ Moreover, it is recognized that biophysical impacts, human causes, and human responses must be seen in terms of their synergistic relationships, and a regional approach is the only feasible way to understand the role of regional historical, cultural, political, and socio-economic contexts in environmental change.

* biophysical: 生物物理学的, synergistic: 相乗的

問 1　本文中の（ 1 ）から（ 5 ）に入る適語を文中より選び，解答せよ．

問 2　下線①の英文を和訳せよ．

問 3　下線②の英文を和訳せよ．

問 4　下線③の英文を和訳せよ．

問題 IIA　以下の英文を和訳せよ.

For more than a century geologists have concentrated mostly on the land forms and deposits left behind by glaciers and icecaps. In recent years, however, oceanographers, climatologists, geochemists, and many other specialists have combined forces to increase our understanding of the climates of our glacial past. Some of this heightened interest has resulted from the aberrant weather patters of the past decades and from the recent awareness that a change in climate is not inconceivable, even on a human time scale. It is evident that a change in climate, or even increased annual climate variations, could have serious economic, social, and political consequences. Therefore, anything that might enhance our ability to foresee what the climatic is likely to do in the next years or decades will be most useful, perhaps even essential.

Possibly there is enough randomness in the behavior of the atmosphere to preclude permanently any forecasting beyond a few months. Climate, on the other hand, is the average weather, from the human scale of decades to geology's eons. Tomorrow's rain is weather, this autumn's excess of it constitutes a wet season, but several wet seasons in a row may spell a climate change. Climate averages out much of the short-term uncertainty, and influenced strongly by processes such as ocean currents that have greater constancy than air flow. We can therefore hope to understand climate from a long record of observations even while the behavior of the atmosphere remains imperfectly known. If such a long record should be found to contain persistent or periodic elements, we might be able to forecast climate sooner, than we can next season's weather. It is for reasons like this, as well as from normal curiosity, that the study of climate has become a lively and somewhat crowded field.

問題IIB. 以下の文章は熱帯地域の放牧が水循環に及ぼす影響について述べたものである．これを読んで次の問に答えなさい．

問1. Hamilton (1985), Manubag (1985), Swift (1973), Baker (1973), Stocking (1985), Mahadevan (1982) がそれぞれ何を明らかにしてきたか、直訳ではなく、言葉を補いながら説明せよ。

問2. 下線部を "The latter"の内容を具体的に示しながら、和訳せよ。

問3. 著者は、社会経済的状況、水文学的変化、植生の変化、家畜の数等の相互関係をどのように捉えているか、図示せよ。

Conversion of an area to grassland may be advantageous or the opposite in hydrological terms depending upon the objectives and the particular environment, including previous land use, soil and rainfall characteristics and management practices. In many cases, grass uses less water than other vegetation and hence many experiments indicate that a change from forest to grass increases water yield with a rise in the water table. Hamilton (1985) points out that these experiments often indicate little or no increase in stormflow and peakflow volume depending on grass density and productivity and that once grass is established, there is no difference in erosion rates and sediment production. However, the experiments have usually been on only moderate slopes and also have not involved grazing. Although controlled grazing and prescribed burning need not have serious effects such control is difficult and overgrazing and indiscriminate burning have adverse hydrological and soil erosion effects. Manubag (1985), for example, indicates much greater surface runoff and sediment production from grazed than ungrazed areas in the Philippines.

Problems associated with hydrology in grazing areas cannot be separated from the whole ecosystem and the economic, social and political circumstances. Swift (1973) discusses the way in which, a nomadic Tuareg tribe protected itself against drought in northern Africa and how this protection has been eroded by changes outside their control such as political restriction on their movements. Baker (1973) indicates common misconception about problems facing pastoral areas. Traditional systems were ecologically well adapted to the environment, but change such as increase in

human and animal numbers due to disease control and restriction on tribal warfare, can lead to overgrazing. Attempts to improve the situation have often failed because of lack of understanding of the people and their traditions, inadequate educational programmes and attempts to gain their support. The complex socio-economic importance of livestock in traditional societies is pointed out by Stocking（1985）. For this reason, simple approaches to overgrazing by reducing livestock numbers will fail. 0verstocking is merely a symptom of broader problems. Solutions must use a sensitive approach to development together with simple range management techniques and development of marketing facilities to increase quality and reduce grazing pressure. Mahadevan（1982）stresses that solutions must be based on a combination of educational, technical, economic and social considerations.

Trampling by excess animal numbers and raindrop impact on the unprotected soil surface leads to compaction with a resultant decrease in infiltration capacity. The latter will prevent the build-up of soil moisture reserve for use in dry periods, the recharge of ground water supplies and at the same time lead to an increase in overland flow. The consequence will be a very irregular streamflow, alternating between spate flow with resultant flooding danger and little or no dry season flow since underground water reserves which maintain it are not recharged. The latter will also lead to wells drying up.

(Jackson, I.E. : Climate, water and agriculture in the tropics より一部改変)

(註) indiscriminate：無差別的, nomadic：遊牧民の, misconception：誤解, symptom：徴候, infiltration：浸透, spate：洪水

問題 IIC　以下の文章を読んで次の問いに答よ.

The law of universal gravitation was discovered by Sir Isaac Newton, and was first announced by him in the year 1686. It may be stated: Every particle of matter in the universe attracts every other particle with a force (F) which is directly proportional to the product of the masses of the particles (m, m') and inversely proportional to the square of the distance (r) between them.

The proportion above may be converted to an equation on multiplication by a constant G, which is called gravitational constant. Thus, the law can be expressed as follows,

[　　] ・・・・・・・(1).

There seems to be some evidence that Newton was led to deduce this law from speculations concerning the fall of an apple to the earth. However, his first published calculations to justify its correctness had to do with the motion of the moon around the earth.

(A) The numerical value of the constant G depends in the units in which force, mass, and distance are expressed. Its magnitude can be found experimentally by measuring the force of gravitational attraction between two bodies of known masses m and m', at a known separation. For bodies of moderate size the force is extremely small, but it can be measured with an instrument which was invented by John Michell, although it was first used for this purpose by Sir Henry Cavendish in 1798. The same type of instrument which was also used by Coulomb for studying forces of electrical and magnetic attraction and repulsion.

Since the constant G can be found from measurements in the laboratory, the mass of the earth (M) may be computed. From measurements on freely falling bodies, we know that the earth attracts a one-gram mass at its surface with a force (F) of 980 dynes. The distance between the centers of the masses is the radius of the earth, R=6380 km. Therefore, we can calculate the mass of the earth (M) from equation (1), and can obtain $M=5.98\times10^{27}$g. The volume of the earth is V=

(次頁に続く)

$(4/3)\pi R^3=1.09\times10^{27}$ cm^3. The mass divided by the volume is known as the density, the value for water being $1g/cm^3$. The average density of the Earth is therefore (2). This is considerably larger than the average density of the material near the earth's surface, so that the interior of the earth must be of much higher density.

The acceleration of gravity (g), is the acceleration imparted to a body by its own weight. Its weight (w), however, can be written $w=GmM/r^2$, where m is the mass of the body, M is the mass of the earth, and r is the distance to the earth's center. Then, since $w=mg$, the acceleration of gravity (g) can be expressed as,

[ ] · · · · · · · (3).

(B) Since G and M are constants, the acceleration of gravity decreases with increasing distance from the center of the earth, and it is only approximately correct to state that a body falls toward the earth with constant acceleration. Actually, the acceleration continually increases as the body approaches the earth, air resistance being neglected. For most purposes, however, this variation is negligible. The acceleration of gravity varies somewhat from point to point on the earth's surface, partly because of variations in the distance to the earth's center and partly because of local deposits of ore, oil or other substances whose density is greater or less than the average density of the earth.

From a survey of variations in the value of g, conclusions can be drawn as to the presence of deposits of ore or oil beneath the earth's surface. Hence the precise measurement of g is one of the methods of geophysical prospecting.

問１．万有引力の法則はどのようなものか，文章の記述に即して述べよ.
問２．この法則を示す式（１）を文章に記された記号を用いて示せ.
問３．下線部分（A）（B）を全訳せよ.
問４．（２）に相当する値を単位を含めて記述せよ.
問５．（３）に相当する式をこの文章に記された記号を用いて示せ.

問題 IIIA 以下の文章を英訳せよ.

(1) 私は宮城太郎です．深浦大学理学部地質学教室の大学院学生です．私は石灰質ナンノ化石生層序学を専攻しています．現在，佐藤教授の指導のもと，北西太平洋における最近 10 万年間の海洋変動を研究しています.

(2) バミューダ産の現世造礁サンゴ 2 群体から，Sr/Ca および U/Ca 比と酸素同位体比の高解像度記録が得られた．これらの 3 つの地球化学的指標は，規則的な季節変化を示し，お互いによく対比される．しかしながら，2 つの群体間には，いくつかの重要な相違点が認められる.

(3) アルケノンは植物プランクトン中の一群によって合成される長鎖分子である．これらのバイオマーカーは多くの堆積物中によい状態で保存されており，そのケトン未飽和指標 $U_k^{37'}$ (ketone undersaturation index $U_k^{37'}$) は表面海水温と密接な関わりがある.

(4) 青葉層は仙台市の西半部に広く分布する．同層は層厚 20m で，主に砂岩からなり，シルト岩の薄層を挟有する．X 線粉末回折分析より，砂岩は主に石英からなり，少量の長石をともなうことが判明している．シルト岩からは，有孔虫，軟体動物，ウニ（echinoid）などの海棲無脊椎生物の化石を豊富に産する.

問題ⅢB. 次の文章を英訳せよ.

あらゆる空間的データは現実世界がもつ諸特徴を概括化，あるいは単純化した結果として得られるものである．ある場合には，データを特定の空間スケールに合わせて表示するために概括化が必要となる．また，概括化はデータを生み出す際に用いられる技術的手続きのもつ限界が理由で必然的になされてしまう場合もある．例えば，写真フィルムの粒子サイズ(grain size)，あるいはリモート・センシング装置の解像度(resolution)といったものは，空中写真や衛星画像の上で見分けることが可能な細かさの水準を決定してしまうのである．概括化はまた，研究者が画像の明瞭さを高めることを，あるいはその画像のなかの主要な題材を際立たせることを目的として行う操作にも伴うものである．地理情報システムにおいて用いられるデータ，例えば空中写真，衛星画像，国勢調査データ，そしてとくに地図のようなデータは全て，すでに概括化を内包している．地図製作者の場合，地表のどのような特徴を地図に含め，どれを除くかについて決定しなければならない．すなわち，地図製作者は地図要素を描くに当たって選択的でなければならない．細部についてのこのような単純化は，全体の明瞭さを保つために必要なのである．

問題 IIIC

和文英訳(以下の全文を英訳せよ)

岩石は大きく、火成岩、堆積岩、変成岩に分類することができる。このうち、堆積岩は、既存の岩石から、直接ないし間接的に生じた粒子からなる岩石である。それらの粒子のあるものは、ある1種の鉱物からなり、あるものは複数の鉱物群からなる。個々の結晶粒は、数ミクロンサイズから数mmに及び、それらの鉱物が複合した粒子にはミリメートルサイズのものから、直径が1メートルを超えるような礫まである。

地球の大気や海洋の進化に関する情報が、ある種の堆積岩に残されていることがある。例えば、先カンブリア紀の堆積岩中に含まれる鉄を含んだ鉱物が示す相対的な酸化度の違いが、当時の大気中に存在した酸素濃度の変化を反映している場合がある。

また古い蒸発岩や頁岩中での硫黄同位体の相対存在度が示す変化が、その当時の海洋における硫黄同位体組成に関する情報を与えることがある。

いろんな時代に形成された地層中に広範に分布する岩塩や石膏、あるいはその他の蒸発岩は、時に過去の気候についての情報を伝えるのみならず、海洋での塩濃度の時間変化をも示唆していることがある。そのような塩濃度の変化は、大量の蒸発岩が堆積することによって、局地的に海洋から塩類が枯渇した結果起こることがあり、海洋における、すくなくとも局地的な塩濃度の時間的変化の原因となりうる。

以上のような例は、かなり一般化された話ではあるが、要するに、これらは、堆積岩の化学組成や鉱物組成を用いることによって、どのようにして地球の歴史を明らかにすることができるかを示す例である。