87-88/7D

INDIANA UNIVERSITY OF PENNSYLVANIA
SENATE CURRICULUM COMMITTEE B-2

NEW COURSE PROPOSAL

Department: Geoscience

Person to contact for further information: Mr. Paul A. Prince
(name and description change only)

Course affected: GS - 362 Plate Tectonics (formerly Marine Geology & Plate Tectonics)

Desired semester of change: Spring 1988

Approvals:

Department Curriculum Committee Chairperson: _____

Department Chairperson: _____

College Advisory Committee Chairperson: _____

College Dean: _____

A. DESCRIPTION OF ACADEMIC NEED

A1. Catalog Description: (PLEASE ATTACH)

A2. Course Syllabus: (PLEASE ATTACH)

A3. Need Fulfilled: It is a culminating course, synthesizing and explaining the major new paradigm in geology. Its aim is to tie together the diverse concepts of all previous geology courses and introduce new geophysical parameters: seismicity, magnetics, heat flow and gravimetric methods as they relate to sea floor spreading, ocean floor creation, kinematics of the plates and dynamics involved in collision and subduction.

A4. Effect on other courses: It is a required core course, and should be taken after Physics I and II and a minimum of 20 semester hours in geology. Essentially the course stands by itself.

A5. Does this course follow traditional offerings in the department? Yes

Two hours of lecture and three hours of lab per week.

A6. Has this course been offered at IUP on a trial basis? Course is #GS - 362 previously entitled Marine Geology and Plate Tectonics. Intent is to drop Marine Geology section as that will be covered in another course, and expand the Plate tectonics portion. So new name of course would be GS - 362 Plate Tectonics. It has been taught as Marine Geology and Plate Tectonics for the last six years.

A7. Is this a dual level course? No.

A8. Do other universities offer this course? Yes at all graduate schools and most progressive undergraduate departments within Pennsylvania; Penn State, Millersville, Slippery Rock, Lehigh, Franklin and Marshall all offer similar courses.

A9. Is this course recommended or required by a professional society? No

B. INTERDISCIPLINARY IMPLICATIONS

B1. Will the course be offered by one instructor or will there be a team?

One Instructor

B2. Are additional or corollary courses needed?

Prerequisites are Physics 111 and 112 plus 20 semester hours in geology.

B3. What is the relationship of the content of this course to the content of courses offered by other departments?

None, it is unique to geology.

B4. Is this course applicable in a program of the school of continuing education directed at other than full-time students?

No. Course too specialized unless student in continuing education has a strong geology background.

C. EVALUATION

C1. What procedures are expected to be used to evaluate student progress? The normal evaluative procedures. Two or three major examinations plus a comprehensive final. A required term paper and 32 assignments.

C2. Variable credit? No.

D. IMPLEMENTATION

D1. What resources are needed to teach this course? All resources on hand. Special 300 page Manual has been prepared. Library resources are adequate. Departmental lab supplies sufficient. Expect no additional instruments or supplies.

D2. How many sections? One section only.

D3. How often will the course be offered? Once a year, second semester

D4. How many students will be accommodated? 20 - 24 maximum

Course Syllabus

Paul Prince
Geoscience Department
Date: November, 1987

PLATE TECTONICS

Course Title: Plate Tectonics
Course Number: GS 362
Credit Hours: Lecture and Laboratory 2c-31-3sh
Prerequisite - one year of physics and 20 semester hours in geology.

Catalog Description: "Introduction to formal theory of plate tectonics. Topics include: magnetic anomalies, first motion studies, thermal structure of the plates, kinematics, crustal generation, sea floor spreading, collision and and subduction deformation".

Objectives: The objectives set forth in this course are:

1. To familiarize the student with the basic paradigm of geology.
2. It is a culminating and synthesizing course, tying together the diverse concepts of geology, while introducing new geophysical parameters in explaining earth development and history.
3. It will impress upon the students the inter-disciplinary nature of geology as it related to other branches of science.
4. To lay a foundation and to stimulate a life-long interest in plate tectonics in which one can apply their talents and imagination.
5. This is a rigorous introduction. Plate tectonics is a branch of continum mechanics and must be taught in a quantified manner. This course will emphasize fundamental physical properties. Course open to any student in any discipline with the proper prerequisites.

Methods: The methods that will be applied in order to meet the objectives of the course are as follows:

1. Lectures and cited personal experiences accompanied by class discussions. Rigorous laboratory exercises and problems.
2. A required reading list chosen from widely recommended and authoratative texts and articles from the various subdisciplines of plate tectonics.
3. Use of numerous slides, charts, posters to illustrate basic principles.
4. A special manual (300 + pages), developed by the instructor for lecture and lab use.

Course Outline: Plate Tectonics

I. INTRODUCTION TO COURSE

1 week

Why teach Plate Tectonics? Background of Instructor. Qualifications to teach plate tectonics. Texts. Reading assignments. Laboratory assignments. Lecture sequence. Examinations. Critique. Citation criteria. Plate Tectonics..a "Kuhnian case".

II. CONTINENTAL DRIFT

1 week

Concepts pre-Wegener. Vertical tectonics-Suessian geology. The German School. Shields and geosynclines. Mobilists vs Stabilists. Theory of Alfred Wegener. Evidences, proofs and energy for continental drift. Special terms. Objections to Drift. Jeffrey and McDonald. The hypsographic curve. The Eotovos (polfluchtkraft) force. Biography of Alfred Wegener.

III. PERSONALITIES Continental Drift to Plate Tectonics

1 day

Frank Taylor. DuToit-Daly-Jeffreys-McDonald-Holmes-Griggs-Blackett-Koppen-Runcorn-Ewing-Heezen-Menard-Dietz-Bullard-Wilson-Morgan-Parker-The "Cambridge School" - the "Menlo-Park" Boys.

IV. INTRODUCTION TO PLATE TECTONICS

1 week

Introduction - a geometric fit-quantification-boundaries-restraints-predictive-analogs. Basic correlaries. Problems of proof. Kinematics of plate tectonics. Basic motions. Precambrian plate motions.

V. GEOMAGNETISM and PALEO-MAGNETISM

2 weeks

Introduction-lodestone-Gilbert-Gauss-terms-dimensions. Dipole and monopole. Strength-changes-reversals of dipole. The "flip-flop" circuit. MHD and Elasser theories. Magnetism: dia-para-ferro-J_m and J_i - ordering of atomsferro-anti-ferro-canted ferro- and ferri. Coercion effect. The Barkhousen effect. TRM and Curie temperature-Blocking temperature-and Relaxation time. The Koenigsberger ratio. DRM and CRM-uses and limitations. Instrumentation: Proton precession-electron-astatic-flux gate-spinner. Collecting magnetic samples in the field. Field tests: reversals-baked contact test, and Grahams fold test. Cleaning samples-AC and thermal. The geocentric axial dipole hypothesis. Problems: field reversal vs self reversal. The dynamo theory. Hystersis. The "Theda" method. Magnetic anomalies-"zebra stripes" -polarity time scale-special terms. Uses and limitations of anomalies. Theoretical vs actual anomalies. Historical sequence. Anomalies and spreading rates. The accretion process. Magnetic smooth zones. Magnetic bights. Magnetic flux and climate.

VI. KINEMATICS OF PLATE TECTONICS

1 week

Introduction. Euler's theory-Rodrigues theory. Instantaneous vs Finite motions. Present world kinematic patterns-vectors of motion. Geohedron. External and internal frames of reference. Transform faults-what they are and what they are not. Types that exist. Analogs. Seismic zones. Latitutde of plates. Locking the plates in. Morphology of transform faults. Polarity changes. Triple Junctions: types that exist-basic diagrams. Stable and unstable types. World examples. Aulacogens. Historical development. Formation and characteristics. Diagram and geologic significance.

VII. PERSONALITIES IN PLATE TECTONICS

1 day

Modern workers. Best articles and texts to read.

Course Outline: Plate Tectonics

VIII. ACCRETION-SPREADING CENTERS-RIDGES AND RISES

1 week

Proper terms. Plate boundaries-vectors of motions. Rift valley morphology. The Heezen zones. Basic parameters across ridges and rise. Sequence: doming-rifting. The Red Sea. The Rhine graben. Iceland. Hydro-thermal conditions. Aqueous fluids and ores. The Galapagos. Sulphide ore deposits. Sea water and igneous cooling. Kuroko-Cyprus-Carlsberg. He^3. TiO_2. Oceanic Crust: the ophiolitic complex. Metamorphic facies. Problems. Tectonics of ridges-morphology. Spreading rates-vectors. Elevation vs age ratio. Sedimentary facies. Ponded sediments. Oceanic sediments in time. Special topics: Project FAMOUS. Global magnetic episodes. The magma chamber. Aseismic ridges. Ancient continental mantle. Bonatti's hypothesis. Characteristics of mid-oceanic basalts.

IX. INTRODUCTION TO SEISMOLOGY

2 weeks

Introduction-elastic rebound theory. Seismic waves-body and surface. Movement of ground material-radiation patterns. Wave velocities. Snell's Law. Refraction and Reflection-discontinuity effects. Wave propogation: homogenous and earth with core. Polarization. Residuals. Travel time graphs. Triplication and shadow zones. Dislocation theory. Quake pre-cursors. Magnitide and intensity scales. Array stations. WWSSN and LASA. Location of stations: hyperbola-circle methods. Focal depth. Seismic silences-gaps and Mogi's Donuts. Focal mechanism-fault plane solutions or Ist motion studies. The Bellingham seismograph exercise.

X. STRUCTURE AND CHARACTERISTICS OF THE MANTLE

1 week

Parameters used. Mantle characteristics-temperature-gravity. Heat flow data. Convectional cells. Harmonics. Geochemistry. Problems.

XI. SUBDUCTION TECTONICS-CONSUMING BOUNDARIES

1 week

Introduction. Basic terminology. Back-arc basins. Island arcs. Volcano spacing and heights. Mineralogy. New theories: Sleep-Andrews-Anderson-Toksoz. Geophysical and geochemical constraints at converging boundaries. Benioff zones. Oil migration-mineralization. Models of stress and flow. India and Tibet as examples. Suture problems.

XII. HOT SPOTS AND PLUMES

1 week

Introduction. Location of hot spots. Some examples: Yellowstone. Theories: Wilson-Dewey and Burke. Chemical and thermal plumes. Critique of plume theory. New Ideas.

XIII. DRIVING MECHANISM OF PLATES

1 week

Introduction. A "push" or a "pull". Drag and shear problems. Convectional cells. Whole mantle or part convection. Theories of: Criggs-Richter-McKenzie-Morgan-Warren Carey. The expanding earth theory.

XIV. OBJECTIONS TO PLATE TECTONICS

1 day

Acceptance or rejection. Flux? How far in the past to extend PT? Objections of: Briden-Mantura-Zonenshain-Khain-Wesson-the Myerhoffs-V.V. Beloussov-Von Bremmelen and S. Warren Carey. Majors and minor problems in the science of plate tectonics. The future!

XV. ADDENDUM-MISCELLANEOUS TOPICS

Plate Tectonics:

Evaluation Methods:

Several written hour examinations and a long comprehensive final. All exams are essay. No curve is used only a straight percentage scale. Final grade computed from examinations, term papers, and laboratory exercises and problems. Examination will count 70% of the grade, while term paper and laboratory exercises 15% each. A is 90% above, while B is 80% above and so forth. Anything below 59% is F.

Texts:

1. Lecture and Laboratory Manual in Plate Tectonics by Paul Prince. Second Edition, 1981, 380 pages.
2. Plate Tectonics and Geomagnetic Reversals. Edited bgy Alan Cox. Freeman and Company, 1973.
3. Extensive readings from texts and journals, representative examples below.
   Plate Tectonics - How it Works by Alan Cox and Robert B. Hart. Blackwell Scientific Publication, 1987.
   Paleomagnetism and Plate Tectonics by M.W. McElhinny. Cambridge Univ. Press. 1973.
   Plate Tectonics - Developments in Geotectonics by X. LePichon; J. Francheteau. Elsevier and Company, 1976.
   The Way The Earth Works by Peter J. Wyllie. Wiley & Company, 1976.
   Instructor has prepared (with permission from publishers) a special 200 page collection of reprint articles from Nature, Science- AAAS, GSA Bulletin and other journals.

Catalog Description
GS - 362
Geoscience Department
November 23, 1987

PLATE TECTONICS

GS - 362 Plate Tectonics 2c-31-3sh
Prerequisites: PH111/112 and a minimum of 20 semester hours of geology.

"Introduction to formal theory of plate tectonics. Topics include: magnetic anomalies, first motion studies, thermal structure of the plates, kinematics, crustal generation, sea floor spreading, collision and subduction deformation."