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CONTINENTAL ENDOGENOUS REGIMES

ИЗДАТЕЛЬСТВО · МИР ·

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Эндоге
матери

Издат

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Continental Endogenous Regimes

Translated from the Russian by
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Mir Publishers · Moscow

First published 1981
Revised from the 1978 Russian edition

На английском языке

Preface

The first and foremost goal of this book is to characterize most thoroughly various continental endogenous regimes. In trying to achieve this goal, the author based his analysis on such features of these regimes which indicate what they have in common and what differences they possess. A list of the regimes under consideration has been prepared in accordance with the classification of continental endogenous regimes previously proposed by the author. It lacks, however, the regimes that can more expediently be considered together with the regimes of the ocean floor, namely those of continental margins. According to the author's knowledge, this is possibly the first attempt to give complete characteristics of endogenous regimes. Geological literature contains many definitions of the terms "geosyncline" or "platform", but other regimes, especially those of intermediate character, have still been described in an extremely general way and frequently with contradictions. The views concerning the differences between a eugeosyncline and a miogeosyncline, an orthogeosyncline and a parageosyncline, or a young and an ancient platform, change from author to author, and these names are often thought of as "loose terms", rather than strict notions. Meanwhile, the necessity to characterize the known endogenous regimes with a maximum possible accuracy is of utmost importance, all the more at present, when geology is closely linked to other Earth sciences.

The author is aware of the fact that his characteristics of continental endogenous regimes are not all encompassing. But it seems to him that this first attempt shows that the goal set forth can well be achieved and a set of indications exists whose handling would permit finding both the similarities and differences between the regimes whatever gradations exist between them.

The second goal of the book is to show that the regimes are connected with each other forming chains in which, when one regime gives way to another, some properties disappear or reappear, while others are retained, though change their relative importance. A question arises whether these changes within the chain result from a consistent evolution of a single factor that lies at the basis of all regimes or the deep sources are different for different regimes. The author tries to demonstrate that there exists a profound "consanguinity" among regimes, and their differences are chiefly due to the different intensities of one and the same cause.

The "consanguinity" of the endogenous regimes and their capability to grade from one to another are particularly well seen from their combinations in time and space. The corresponding pages of this book present laws governing the sequence of the regimes and their spatial combinations.

In the last chapter the author formulates the problem of a common deep source of endogenous processes and comes to a conclusion that this source is the internal heat of the earth: the change of regimes in time and their spatial combinations are basically the result of temporal and spatial inhomogeneities in the earth's heat flow.

Obviously, some aspects of the deep-seated mechanism suggested by the author for the origin of endogenous regimes are still hypothetical. The author hopes, however, that other aspects of this same mechanism are real, whereas the hypothetical elements can be used to show the lines of further investigation. An attempt has been made in the last chapter to confront the various endogenous processes and their combinations on continents with the kinematic scheme suggested by the "plate tectonics" theory, which is so fashionable now.

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Introduction

In elaborating traditional conceptions on the various types of tectonic regimes, the author attempted to specify and generalize them in his latest writing. He proposed a classification of continental endogenous regimes, based on different combinations of tectonic, igneous, and metamorphic processes. He distinguished the following classes of regimes: geosynclinal, platform, orogenic, rift, magmatic platforms activization, and marginal. These classes, in turn, are subdivided into fourteen regimes (*see* Table).

In an attempt at correlating the type of an endogenous geological regime with deep-seated processes, it has been established that the correlation is best between the properties of the regime and its associated heat flow. More active regimes are due to enhanced heat flows, whereas quiet ones, to normal or low values of the heat flow.

The sequence of endogenous processes indicates the presence of the phenomena of two orders in the history of the earth's crust. First, the crust generally tends to evolve in such a way that the role of active regimes gradually decreases, while that of quiet regimes correspondingly increases. As a result, the most ancient permobile stage gave way to an unstable protogeosynclinal stage, and later, to a stable geosynclinal-platform stage. This suggests that the energy of deep-seated processes has been changing with geological time. Simultaneously, the excited regimes become confined to more and more limited areas within so-called geosynclinal belts. A certain spatial consistency exists in the arrangement of active regimes on the surface of continents and in the process of their localization. Second, on this general tendency is superimposed a regular succession of individual regimes. Indications of periodic recurrence can here be recognized, consisting in several repetitions of the similar sequence of regimes. The name "quasiperiodic recurrence" is more correct for this phenomenon, because the "cycles" are of unequal duration, and the very sequence may be different for different cycles and regions, though the major general features of the cycles are always retained.

Properties of the Continental Endogenous Regimes

Class of regimes	Regime	Stage of deve- lopment	Contrast and intensity (rate and amplitude) of oscillatory movements	Relationship between subsidence and uplift	Predominant sedimentary formations
Geosyn- clinal	Eugeosyn- clinal	Preinver- sion (ophioli- tic)	High	Considerable preponderance of subsidence; uncompensated downwarping	Lower terrigenous and deep-water siliceous (jasper)
		Inversion	Moderate	Equilibrium between subsidence and uplift	Upper terrigenous (flysch, caustobiolithic)
		Postinver- sion	Low	Slight preponderance of uplift	Lower molasse
	Miogeo- synclinal	Preinver- sion (com- pensated subsidence)	Moderate	Preponderance of subsidence	Lower terrigenous (black shale), followed by shallow-water limestone
		Inversion	Low and moderate	Equilibrium between uplift and subsidence	Upper terrigenous (flysch, caustobiolithic)
		Postinver- sion		Slight preponderance of uplift	Lower molasse
	Parageo- synclinal		Low and moderate	Preponderance of subsidence; slight preponderance of uplift at end of cycle	Sandy-clayey (lower terrigenous), followed by limestone which often predominates; above lies upper terrigenous formation, including flysch and caustobiolithic
	Median masses		Low	Equal development of slight uplift and subsidence	Sandy-clayey and limestone
Orogenic	Epigeo- synclinal		High	Considerable prevalence of uplift	Molassic and lagoonal, including caustobiolithic

Character and degree of the crust's permeability	Characteristic magmatism	Regional metamorphism and granitization	Type of folding	Characteristic type of faults
Diffused, high	Basic underwater outpourings and layered intrusions (sills, laccoliths); ultrabasic rocks (ophiolites); intermediate and acid outpourings and plagiogranite intrusions at end of stage	Propylitization, "blueschist" facies	Folding is not characteristic; block folds on intrageanticlines	Deep-seated slashes
Concentrated, low	Granite batholiths	Regional metamorphism and granitization (batholiths)	General crumpling and deep folding	Thrust faults, nappes of Helvetic and Pennine types
Concentrated	Vein intrusions, dikes	Absent	General crumpling, injection and block types in depression	Nappes of Helvetic type, deep-seated slashes
Diffused, low	Absent or slight manifestations of basic outpourings and layered intrusions (sills)	Absent	Absent or weak block type	Deep-seated slashes
Concentrated, low	Granites, small normal and alkaline intrusions	Moderate greenschist metamorphism and granitization	General crumpling, deep-seated	Thrust and reverse faults, Helvetic-type nappes
Concentrated	Vein intrusions	Absent	Injection and block types	Nappes of Helvetic type, deep-seated slashes
Concentrated, low	Generally weak magmatism manifested by basic dikes, sills, alkaline laccoliths, and magmatic diapirs; vigorous outpourings of intermediate and alkaline magmas in "volcanogenic" parageosynclines	Absent	Block and injection types	Reverse faults, deep-seated slashes
Concentrated, high	Diverse effusive rocks of basic, acid, and alkaline compositions; fissure-type basic, acid, and alkaline intrusions	Absent or slight	Block type	Deep-seated slashes, reverse faults
Concentrated, high	Preponderance of intermediate and acid lavas; fissure-type basic, intermediate, and acid intrusions	Absent	Block and injection types; local occurrences of general crumpling	Deep-seated slashes; normal, reverse, and thrust faults

Class of regimes	Regime	Stage of development	Contrast and intensity (rate and amplitude) of oscillatory movements	Relationship between subsidence and uplift	Predominant sedimentary formations
Orogenic	Epiplatform (tectonic activization of platforms)	—	High, moderate	Considerable preponderance of uplift	Molassic and lagoonal, including caustobiolithic
Rift	Rift	—	Moderate, high	Subsidence of grabens within gentle and broad uplift	Molassic and lagoonal
Platform	Protoplatform	—	Low	Slight preponderance of subsidence at beginning of cycle; slight preponderance of uplift at end of cycle	Predominantly very thick terrigenous
	Ancient platforms	—	Very low	Equilibrium between subsidence and uplift, but slight preponderance of former at beginning, and of latter at end, of cycle	Common succession of formations (in ascending order): (a) lower terrigenous, including bituminous; (b) limestone; (c) upper terrigenous, including caustobiolithic; and (d) molassic and lagoonal
	Young platform	—	Low	Equilibrium between subsidence and uplift, but preponderance of former at beginning, and of latter at end, of cycle	Common succession of formations is same as on ancient pl tforms
Magmatic activization of platforms	Plateau-basaltic	—	Very low	Slight preponderance of subsidence	—
	Central complexes and explosion pipes	—	Very low	—	—
Continental margins	Atlantic-type	—	Low	Subsidence predominates	Sandy-clayey, lagoonal, caustobiolithic
	Pacific-type	—	Very high	Subsidence predominates	Sandy-clayey

Continued

Character and degree of the crust's permeability	Characteristic magmatism	Regional metamorphism and granitization	Type of folding	Characteristic type of faults
Concentrated, high, and moderate	Basic and alkaline outpourings; fissure-type intrusions of same compositions	Absent	Block and injection types, local occurrences of general crumpling	Deep-seated slashes; normal and thrust faults
Concentrated, high	Basic and alkaline outpourings	Absent	Block type	Slashes, normal, and reverse faults; basic structural features are grabens
Concentrated, moderate	Outpourings of acid and basic lavas. Major layered intrusions — lopolites	Greenschist metamorphism, granitization along faults	Very large domes, flexures	Deep-seated slashes
Impermeability	Absent or very slight manifestations of basic and alkaline outpourings and slight intrusions	Absent	Block and injection types	Slashes, normal and reverse faults
Concentrated, very low	Slight manifestations of basic outpourings, fissure-type intrusions, and laccoliths of alkaline composition	Absent	Block and injection types	Slashes, normal and reverse faults
Concentrated, moderate or high	Plateau-basalts	Absent	Absent	Normal faults, slashes
Concentrated, high	Intrusions of diverse composition (predominantly alkaline): fissure-type, laccoliths, igneous diapirs; kimberlite pipes	Absent	Block type	Normal faults, slashes
Concentrated, low	Some basaltic outpourings, dikes	Absent	Block and injection types	Normal faults and slashes
Concentrated, high	Vigorous outpourings of andesites and andesitic basalts; granodiorite and granite intrusions	Slight	Block type	Great development of normal faults and slashes; deep-seated thrust faults

In our previous works we called "excited" the regimes under which mantle-derived magmas are generated. They should be more correctly named "excited-mantle" regimes. In contrast, there are regimes under which no mantle-derived magmas are formed. They are referred to as "quiet", but should be more correctly spoken of as quiet-mantle regimes*. If this typification of endogenous regimes is accepted, then in their common succession observed in the most active zones, where a eugeosynclinal and an orogenic regime alternate, one can see a quasiperiodic recurrence of mantle excitation and quiescence; the preinversion (ophiolitic) stage of the eugeosynclinal regime corresponds to a thermally excited state of the mantle, the inversion stage of the same regime corresponds to its quiet state, and the mantle is again excited under the orogenic regime.

It cannot be rejected that such an approach to the recognition of types of endogenous regimes is too narrow minded, because it does not take into account the processes in the crust. At the inversion stage of the eugeosynclinal regime, when the absence of mantle-derived magmas allows us to speak of the quiet state of the mantle, regional metamorphism and granitization, which require high temperatures, take place in the crust. This is the stage of thermal excitation in the crust; therefore, the periodic recurrence of endogenous conditions, taking account of the events in the crust, turns to consist in the alternating excitation of the mantle and the crust.

It should also be borne in mind that some endogenous regimes are devoid of the thermal excitation of both the mantle and the crust. These are, for instance, platform regimes. But they may alternate with an epiplatform orogenic regime. In this case the periodic recurrence of regimes consists in an alternation of conditions, when either all of the tectonosphere is in a quiet state, or the mantle is excited while the crust is still quiet.

It would apparently be more correct to call "excited" those regimes equally related to the thermal excitation of both the mantle and the crust. It is all the more justified that the thermal excitation of the crust is not an independent phenomenon—it either occurs simultaneously with the thermal excitation of the mantle or, more frequently, immediately follows melting processes in the mantle. The mantle always transfers the heat of deep interior into the crust. With this correction, both the stages of the eugeosynclinal regime can be assigned to excited regimes, whereas only regimes without thermal excitation neither in the mantle nor in the crust can be considered quiet.

However, because the excitation involves both the mantle and the crust, it is expedient to use the terms "hot" and "cool" to distin-

* Wherever the mantle is spoken of, the upper mantle, and generally only its portion where partial melting takes place, i.e. the asthenosphere, is implied.