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A note on a late revision of the theory of embryotectonics by Argand himself

By A. M. Celal Sengör[1])

«L'univers s'écoule, emportant les voies lactées et les mondes, les Gondwanies et les Eurasies, les visions inconsistantes et les systèmes trop gros. Mais les bons édifices d'idées, ces *serena templa* de l'intelligence auxquels ont travaillé quelques maîtres, ne périssent jamais tout entiers. Ils sont le grand legs du passé. Ils durent sous des formes de plus en plus harmonieuses, et tout bien vu, ils ne cessent de grandir. Ils confortent par le grand art qui en est inséparable. Leur pérennité se fonde dans l'immortelle poésie du vrai de ce vrai qui nous est donné en parcelles infimes, annonciatrices d'un ordre dont la majesté domine le temps.» Argand

ABSTRACT

In its original and the most popularly known form, the theory of embryotectonics of Emile Argand postulated a continuous compressional development of the large, highly asymmetric anticlinal nappe embryos constituting ridges within the Alpine "geosyncline" between the late Carboniferous and the final Tertiary paroxysm, without clearly indicating how the geosyncline itself had originated to begin with. Argand's interpretation of the nature of the tectonic control on Alpine paleogeography has since been criticized, because later detailed work during the 1930's and 1940's not only failed to find any evidence of pre-Cretaceous Mesozoic compression, the existence of which was demanded by Argand's view, but actually discovered evidence for extension. Argand's critics, however, seem to have overlooked a revision of the theory of embryotectonics that Argand himself had made. In 1934, in his introductory summary of the geology and the tectonic evolution of the Pennine Zone, written as a part of the "Geological Guide to Switzerland", Argand explicitly stated that the Alpine geosyncline had formed by crustal extension beginning with the medial Triassic and that during the Lias the entire geosynclinal complex had subsided because of advanced stretching. Argand believed that a number of compressive interludes interrupted the extension, which, however, had continued until the late Jurassic. Although Argand had thus anticipated the idea of the extensional origin of the Alpine geosyncline, his ideas were not identical to those that developed during the 1950's on the basis of the fieldwork of 1930's and 1940's. The most important differences between Argand's view and the later interpretations are his insistence on the existence of pre-Cretaceous compressive phases that supposedly had interrupted the extensional evolution and his continued belief in the lateral and temporal persistence of paleogeographic units.

ZUSAMMENFASSUNG

In ihrer ursprünglichen Form setzte die berühmte Theorie der embryonalen Tektonik von Emile Argand eine kontinuierliche kompressionale Entwicklung der grossen, asymmetrischen Deckenembryos, die Schwellenregionen in der alpinen «Geosynklinale» gebildet hatten, zwischen dem Oberkarbon und dem endgültigen tertiären Paroxysmus voraus, ohne darauf hingewiesen zu haben, wie überhaupt die

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Geosynklinale selbst entstanden war. Seitdem hat man die Argandsche Interpretation der tektonisch bedingten Paläogeographie des alpinen Raumes kritisiert, nicht nur weil die detaillierten Feldarbeiten der 30er und 40er Jahre keine Anzeichen der von Argand verlangten Vorkreide-Kompressionen hervorbrachten, sondern auch weil sie Hinweise für eine mesozoische Zerrungstektonik lieferten. Die Kritiker von Argand scheinen jedoch eine von Argand selbst unternommene Revision der embryonalen Tektonik übersehen zu haben. In seiner 1934 als Teil des «Geologischen Führers der Schweiz» publizierten Einführung in die Geologie und in die tektonische Entwicklung des Penninikums schrieb Argand deutlich, dass die alpine Geosynklinale während der mittleren Trias durch krustale Dehnung entstanden war und dass während des Lias der gesamte Geosynklinalkomplex wegen der fortgeschrittenen Dehnung weitergesunken war. Eine Anzahl von kompressiven Phasen sollte die extensionale Entwicklung der alpinen Geosynklinale unterbrochen haben, obwohl die Dehnung im allgemeinen bis Ende des Juras gedauert haben sollte. Obwohl Argand die extensionale Entstehung der alpinen Geosynklinale damit vorausgesehen hatte, decken sich seine Ansichten nicht völlig mit denen, die während der 50er Jahre entwickelt worden waren. Die wichtigsten Unterschiede sind Argands Bestehen auf der Existenz der kompressiven Vorkreide-Phasen und sein Glaube an die räumliche wie auch zeitliche Persistenz paläogeographischer Bereiche.

1. Introduction

Although Argand's ingenious hypothesis of embryotectonics (ARGAND 1916) had dominated the evolution of thought on the geological development of the Alps for about four decades, it had to be abandoned by the late 1950's because of accumulating new evidence in favor of an extensional tectonic regime in the "Alpine geosyncline"[2]) during the medial Triassic to Cretaceous interval. The critics of embryotectonics not only demonstrated the presence of crustal extension (or, at least, the absence of shortening: *« ... une tectonique peut-être de traction mais certainement pas de compression»*, TRÜMPY 1957, p. 446), but also denied the one-to-one correlation of the present tectonic units with former paleogeographic domains and the implied continuity, both in time and in space, of the latter. The criticisms of embryotectonics that brought about the revolution in Alpine tectonic thinking in the fifties and released it from the influence of Argand's authority were all directed against the original version of embryotectonics, published in the now-classic *Sur l'arc des Alpes occidentales*, in 1916. The fact that Argand's ideas both on Alpine evolution and on tectonics in general had continued to evolve, sometimes involving drastic changes, seems to have escaped the notice of most Alpine geologists, who, consequently, have not paid attention to a later revision of his embryotectonics, that forms the subject of this paper. Argand's revision of embryotectonics, which he published in 1934 in the somewhat disguised form of an introductory summary of the geology and the tectonic evolution of the Pennine Zone as a part of the "Geological Guide to Switzerland" (ARGAND 1934), brought him remarkably close to what his critics developed some quarter of a century later.

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[2]) Throughout this paper my usage of the term geosyncline is only to conform to Argand's terminology and should not be taken as an expression of my approval of continued usage of this term. As I have already stated in other places, I agree with Suess' recommendation that the term geosyncline should be dropped from geological terminology once and for all.

2. The theory of embryotectonics and its harbingers

The theory of embryotectonics (*"tectonique embryonnaire"*, ARGAND 1916, p. 165) of Emile Argand has been, without doubt, one of the most influential theories of orogenic development in the history of tectonics. Argand originally proposed it to explain the paleogeographic and structural evolution of the western Alps (ARGAND 1916). He later extended it to the entire Alps plus the Carpathians (ARGAND 1920) and then to the entire Mediterranean domain (ARGAND 1924*a*).

The idea that the Alpine geosyncline was not a simple trough but was divided into subordinate, longitudinal troughs and swells had been conceived before Argand. Haug, for example, wrote:

«D'autre part, l'histoire géologique d'un certain nombre de régions montagneuses nous apprend que le phénomène de plissement est souvent précéde par la naissance d'un géanticlinal médian dans l'axe du géanticlinal[3]) primitif, qui se trouve alors divisé en deux géosynclinaux secondaires, caractérisés chacun par des formations bathyales, tandis que l'existence du géanticlinal médian est attestée par une étroite zone à faciès néritique.»

In this quotation HAUG (1907, p. 164) not only indicates the multiple nature of the geosyncline, but also points out the precursory nature of the *géanticlinal médian* with respect to later folding and emphasizes its control on the distribution of facies in the *géosynclinal primitif*. It was on this foundation that Argand erected his *tectonique embryonnaire*.

The basic premise of Argand's view was that the ridges that subdivide what he called *la zone géosynclinale d'ordre supérieur* were nothing more than embryonic nappes, i.e. the very first harbingers of some of the large, complex Penninic nappes of the future. Argand recognized two such ridges or cordilleras or, following Haug's terminology, geanticlines: the Briançonnais geanticline, which was to become exaggerated into the Grand-St-Bernard nappe, and the Dolin geanticline, destined to become the Dent Blanche nappe. In the beginning, these geanticlines were believed to have been gentle, but highly asymmetric, large-scale folds with a northerly or westerly vergence. Neritic sediments were viewed as deposits accumulated on the crestal regions of these giant asymmetric folds, whereas deeper water, bathyal and abyssal sediments were thought to have accumulated in the corresponding asymmetric synclines, which Argand simply called "geosynclines". Argand's block diagram, reproduced here as Figure 1, shows this geometry. An additional feature shown in this figure is the mode of formation of greenstones or ophiolites s. l. Argand portrayed their origin in 1916 as submarine effusive rocks emanating along the sheared-out lower limbs of the asymmetric embryonic nappes and pouring into the intervening synclines (also see ARGAND 1911). Argand later reconsidered the ophiolite problem as well in the light of his revised views as we shall see below.

On the origin of his *Zone géosynclinale d'ordre supérieur* itself Argand was notably vague in his 1916 paper; however, it seems clear that he thought that the *géosynclinal d'ordre supérieur* had been born in a compressional environment and that continuous compression had governed its entire evolution. In fact, Argand thought that his embryonic nappes, the geanticlines, were nothing more than Hercynian folds. He wrote (ARGAND 1916, p. 175):

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[3]) I believe this should be *géosynclinal* instead of *géanticlinal*.

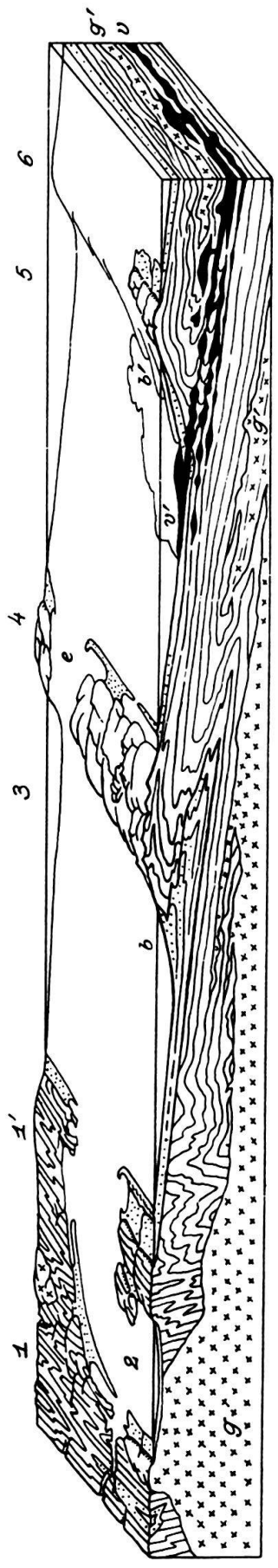

Fig. 1. Argand's block diagram showing the geometry of the Alpine "geosyncline" during the late Carboniferous, according to the original version of the theory of embryotectonics. Note that greenstones or ophiolites s.l. are here portrayed as submarine effusions, emanating along the overturned, sheared-out lower limb of the Dolin geanticline, pouring into the Piemontais geosyncline. From ARGAND (1916).

«A l'origine, les rides et les sillons sont des plis hercyniens; ils sont de plus, comme nous le savons maintenant, les embryons des grands plis couchés tertiaires.»

However, the reader is left in ignorance as to how exactly the geosyncline itself came into being. Argand carefully made the point that its two forelands had been strongly deformed and become stabilized during the Hercynian orogeny, whereas in the geosyncline the Paleozoic and Mesozoic sediments seemed conformable, perhaps indicating the absence of Hercynian folding in it. But this interpretation Argand found unacceptable, because *«un autre phénomène, inséparable du plissement hercynien, c'est manifesté avec une rare intensité: je veux dire la mise en place, au Primaire supérieur, de roches acides profondes, entourées de vastes auréoles d'injection et d'imbibition»* (ARGAND 1916, p. 174). One gathers the image form Argand's descriptions that although Hercynian magmatism was as intensive in the future Alpine geosyncline or Tethys (*«la zone géosynclinale d'ordre supérieur, ou Téthys»*, ARGAND 1916, p. 174) as it was on its forelands, Hercynian deformation simply gave rise to the two geanticlines that subdivided the geosyncline in contrast to the strong Hercynian folding of the forelands. The Alpine geosyncline was, according to Argand in 1916, nothing more than a remnant trough not strongly deformed by the Hercynian orogeny, although it seems that Argand himself was not very clear about the late Paleozoic conditions in the future Alpine area.

In Argand's way of thinking represented by his 1916 paper, one can discern two sources of influence: The first was the idea of the compressional origin of geosynclines. Both HALL (1859) and DANA (1873, 1894) thought that the same stress system was responsible both for the formation and the eventual demise of a geosyncline. DANA (1873, 1894) also explicitly stated that this stress system was compressional, a view which HAUG (1900, 1905) and later STILLE (1924, 1940) shared. I think it was through Haug's writings that the idea of the compressional origin of geosynclines exercised influence on Argand. The second source of influence was SUESS' (1909) identification of the Alps as "posthumous Altaids". SUESS (1909, p. 219) defined the concept of posthumous Altaids as follows:

«Unter dem Ausdrucke ‹posthume Altaiden› sind hier alle jene Gebirgszüge verstanden, welche nach Beendigung des Baues der östlichen Altaiden in den Einsenkungen entstanden, durch welche die Altaiden in Horste getheilt worden sind. Alle diese posthumen Ketten haben in tertiärer oder noch späterer Zeit Faltung erlitten.»

Argand seems to have combined Suess' idea of a post-Hercynian depression with that of the compressional origin of geosynclines in general and arrived at his own picture of the embryonic stage of the Alps just after the Hercynian orogeny. Then he postulated a simple, straightforward chain of events during which continuous compression exaggerated the embryonic nappes into giant recumbent folds. The rate of deformation increased during the Tertiary paroxysm, forming the giant, crystalline-cored Pennine nappes. The ones other than the Grand-St-Bernard and the Dent Blanche originated later and had no embryonic ancestry (especially the Monte-Rosa nappe).

Thus, embryotectonics was initially conceived and formulated in the atmosphere of the prevailing tectonic hypotheses of the day, which constituted the core of what Argand was to call later "fixism" (ARGAND 1924a, p. 289). However, almost immediately after the publication of *Sur l'arc des Alpes occidentales,* he began revising his

ideas on general tectonics in the light of Wegener's theory of continental drift (see MASSON 1976, p.557; also translator's preface in CAROZZI 1979) of which he was to become the greatest geological champion. In the next section I outline the ideas of the mobilist Argand relevant to the subject of this paper and his revision of embryotectonics in their light.

3. Mobilist view of geosynclines and the revision of the theory of embryotectonics

The foundation for Argand's revision of his view on the origin of geosynclines had already been laid by Wegener. He had argued (WEGENER 1912, 1915) that the Earth's outer shell had been composed of two major subdivisions, namely *sal* (later *sial*), which had made up the continents and *sima* which had made up the ocean floors. Oceans formed where a continent rifted and its two pieces drifted apart. Significantly, Wegener realized that most of what had been called "geosynclinal sediments" had been deposited on continental shelves (WEGENER 1915, p.69). In response to Haug's statement that mountain chains were formed from geosynclines, he wrote (WEGENER 1915, p.35, footnote):

«Ich halte ‹Schelfe› für richtiger als ‹Geosynklinalen›, da man einen Randschelf, wie z.B. den, aus welchem sich die Anden Südamerikas aufgebaut haben, wohl nicht gut als Mulde bezeichnen kann.»

Wegener acknowledged that sediments were indeed thicker and the sequences were more complete in mountain belts than on forelands, but interpreted this as *«Kettengebirge entstehen aus Schelfen»* (WEGENER 1915, p.35), and not in terms of synclinal or any sort of closed basin-formed depressions. This idea may well have led CLOOS (1936, p.460) to his *Geomonoklinal* concept, which is the earliest harbinger I know of Dietz's geocline idea.

Argand admitted that the mobilist view had somewhat neglected the geosyncline concept (*«La théorie mobiliste a quelque peu négligé la notion de géosynclinal»*, ARGAND 1924a, p.299). The origin of his statement was perhaps that, together with Suess and Wegener, Argand too saw no need for an independent mega-structure family of geosynclines. Suess had already pointed out in the last volume of *Das Antlitz der Erde*, that he could see no evidence indicating the existence of geosynclines, and that what had so far been called geosynclines did not show geosynclinal structure, but were perhaps similar to the present-day oceans (SUESS 1909, p.722 and 737–738; also see SENGÖR, in press). Consequently Suess emphasized that there was no need for the term geosyncline. Wegener, as we have just seen, was of a similar conviction.

Two fundamental ideas appear to have been decisive in the way in which Argand revised his own ideas on the nature and origin of geosynclines. One of these was his belief in the overall "plastic" behavior of rocks, and the other his denial of the existence of *any* primary vertical movements of the lithosphere.

His own fieldwork in the Pennine Zone of the canton of Valais and the discovery, by Lugeon and by himself (following Gerlach's initial discovery: see ARGAND 1923, p.96–97) of the giant, crystalline recumbent folds forming the cores of the Pennine nappes had led Argand early in his career to the belief that all rocks had a more-or-less plastic character. He devoted an entire section to this concept in his *Sur l'arc des*

Alpes occidentales (ARGAND 1916, p. 157–159) and later made extensive use of it in *La Tectonique de l'Asie* (ARGAND 1924a, particularly p. 226–228 and Fig. 9 and 10). Also in *La Tectonique de l'Asie* (especially p. 174–177) Argand sharply criticized tectonic interpretations that relied on the postulate of pure, primary vertical movements. He argued that *all* vertical movements of the Earth's outer shell ultimately resulted from horizontal movements and represented nothing more than their vertical component. He wrote (ARGAND 1924a, p. 174):

«C'est que les objets tectoniques, en se rétrécissant sous l'effort tangentiel, sont bien obligés de monter ou de descendre en gauchissant: il y a donc un effet vertical qui dérive directement de l'effort tangentiel, et trop souvent cet effect a été pris pour un mouvement vertical indépendant de la déformation.»

The combination of these two ideas, i.e. the general plasticity of rocks and the nonexistence of primary vertical movements led Argand to two important concepts: one was that of *plis de fond* (=basement folds) and the other the extensional origin of geosynclines. Under compression, a normal-thickness continental crust was deformed, according to Argand, by means of *plis de fond*, that appeared either as large wavelength crustal folds or, more often, as packages of basement thrusts that served to thicken the continental crust (see ARGAND 1924a, Fig. 5). Although crustal "synclines" naturally formed between two successive crustal "anticlines", Argand did not believe that such "synclines" could have formed major geosynclines. Instead, he visualized geosyncline formation as an *extensional tangential* process that resulted from the *plastic attenuation* of the continental crust and its consequent foundering due to thinning during continental separation (Fig. 2). Argand's "revised" view of geosyncline formation and its application to the origin of the Alpine geosyncline constitute the central theme of this paper. For that reason I quote him fully from *La Tectonique de l'Asie* concerning geosyncline formation in the following (ARGAND 1924a, p. 299):

«Un géosynclinal résultera en général, d'une *traction* horizontale qui étire le radeau de sal. L'étirement est d'abord plus aisé dans les profondeurs du sal que dans les hauts, où peuvent naître des fissures d'extension. En s'amincissant, le sal descend et se creuse: l'affaissement inhérent à la fonction géosynclinale n'est donc pas demandé à un jeu radial originaire: il n'est que l'effet vertical d'une distension horizontale ... Jusqu'à compensation, le sima monte sous le sal aminci: ce jeu rend compte de la fréquente association de roches vertes à des sédiments bathyaux ou abyssaux ... Les pieds-droits de la zone amincie, qui ont conservé l'epaisseur normale du sal, sont les serres du géosynclinal. La compression vient-elle à remplacer la traction, les serres se rapprochent et le jeu géosynclinal classique avec son plissement embryonnaire par cordillères, sillons et avant-fosses véritables, commence: la conclusion, presque toujours, est la mise en place de deux chaînes géosynclinales à déversements opposés.»

In this quotation Argand explicitly stated, I believe for the first time, that *extensional tectonics* must have already created a geosyncline, before the embryonic foldings, i.e. the first products of beginning compression could have formed (Fig. 2). However, in *La Tectonique de l'Asie* Argand still makes no mention of the extensional origin of the Alpine geosyncline (see also BAUD & MASSON 1975, p. 143). In fact, in the eleventh of his twelve introductory remarks (p. 178–179), he spoke of the continuity of certain geosynclines through two orogenic cycles – he indicated that the Alpine geosyncline represented what had remained of "the geosyncline" after the Hercynian deformations. Thus, in 1924, Argand had still not completely liberated himself from his original views of 1916. Only in 1934 he clearly indicated that a

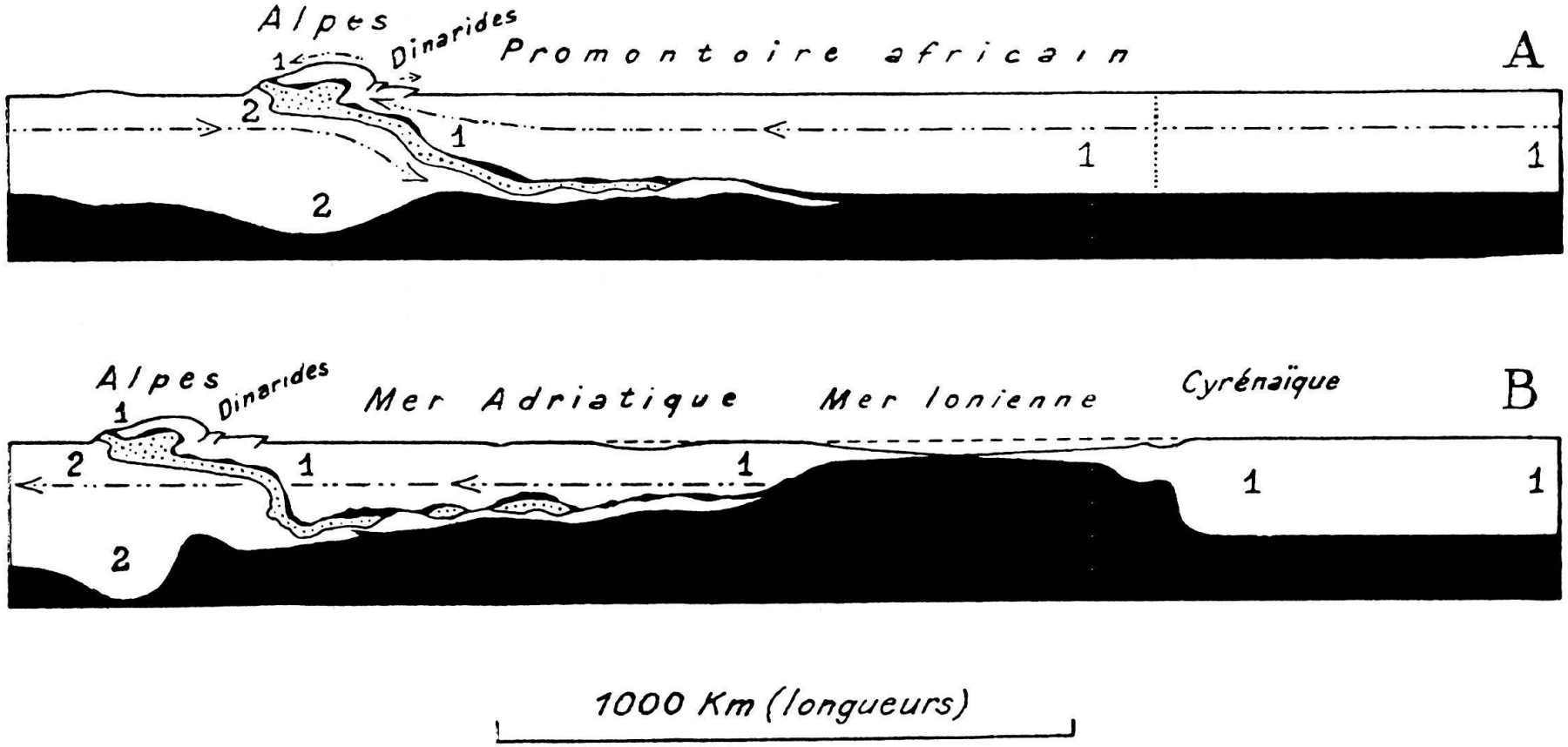

Fig. 2. Argand's cross-section to show the evolution of the Ionian Sea, which serves as a model for his revised conception of the origin of geosynclines. In his *Des Alpes et de l'Afrique* (ARGAND, 1924b) from which this figure is copied, he pointed out that the cropping-out of sima beneath the stretched and broken sial was the origin of ophiolites. Thus Argand also anticipated the role of ophiolites in interpreting past divergent environments, but naturally not in a seafloor spreading context.

new or at least *partially new* geosynclinal system had formed in the future Alpine area *after* the Hercynian deformations had affected the entire Alpine domain. His new ideas Argand crowded into the following three paragraphs (ARGAND 1934, p. 182; italics mine):

«J'ai montré ailleurs (As., 1924, p.299) qu'un géosynclinal se forme par distension, et que son évolution ultérieure est régie par des alternances de compressions et de distensions, jusqu'à la compression définitive qui est le paroxysme.

Ce sont des distensions qui, *au début du Trias moyen*, ont rétabli un géosynclinal d'ordre supérieur. Les restes non émergés du géosynclinal hercynien s'y sont trouvés incorporés. Le concours de ces deux facteurs a permis au faciès schistes lustrés de s'établir dans les sillons du géosynclinal dès le Trias moyen, et d'y persister pendant le Trias supérieur. *Pendant le Lias, les distensions s'accentuent et l'ensemble s'approfondit;* ... Un ou plusieurs épisodes de compression s'intercalent pendant le Lias. Je ne puis songer à mentionner ici toutes les alternances de jeux plicatifs et de jeux distensifs. Il suffira de relever les distensions qui, au Jurassique supérieur, ont creusé certains sillons au point qu'il s'y est déposé des radiolarites.

Sillons et cordillères ont été façonnés et refaçonnés, pendant les temps antérieurs au paroxysme, par les jeux alternants des distensions et des compressions.»

In these three short paragraphs (a part of the section entitled *Cinétique alpine* of his general introduction to *La Zone Pennique*) Argand introduces several significant ideas, which, however, he regrettably does not develop.

First, he reiterates his conviction that geosynclines form by crustal stretching and that their *subsequent* evolution is governed by alternating episodes of extension *and* compression. I should perhaps issue a warning here that such alternating episodes of extension and compression ought not to be confused with the *universal alternances* of extension and compression suggested by ROTHPLETZ (1902) and later applied to the origin of geosynclines by BUCHER (1924, 1933). Argand's view of such alternances was that they were due to the capricious movements of the drifting continents and were *local* in nature. Bucher, on the other hand, conceived the extensional origin of geosynclines from the similarity shown by the extensional fracture nets developed on a spherical paraffin shell to the map pattern of the world's mobile belts: extensional episodes affected *all* of the geosynclines of the world *synchronously* and so did the compressional ones in Bucher's view. Neither Argand's nor Bucher's views were based on any concrete field evidence and were both theoretical in nature.

Secondly, Argand indicates very clearly that the Alpine geosyncline sensu stricto began to form through a *medial to late Triassic* extensional regime, albeit it did incorporate remnants of the Hercynian geosyncline as well. *Accentuated extension* and the foundering of the entire geosynclinal complex characterized the Liassic development. This is where Argand departs most drastically from his original picture of 1916 and comes closest to our modern views on the paleogeographic evolution of the Alpine geosyncline developed in the forties and fifties by such workers as GÜNZLER-SEIFFERT (1941, 1952), TRÜMPY (1952, 1955, 1957, 1958), LEMOINE (1953), DEBELMAS (1957) and SCHOENENBERG (1958). TRÜMPY (1957, 1960) gives excellent summaries of these ideas and their development; that is why they are not repeated here.

Thirdly, Argand stressed that compressional movements often interrupted the extensional development and continuously reshaped the embryonic structures. Only after the onset of paroxysm did continuous compression govern the evolution.

This is how far Argand revised his original scheme in print. Towards the end of his life he unfortunately published very little and although it is clear that he had made considerable advances in theoretical tectonics, the details of his discoveries did not survive him.

4. Conclusions: Differences between Argand's final view and our modern concepts on the paleotectonic evolution of the Alps

Argand naturally did not know anything about plate tectonics and did not anticipate any of its main tenets; neither could the critics of embryotectonics have set their views in a plate tectonic framework during the fifties. I shall therefore leave any discussion of the contributions of plate tectonics to our understanding of the paleotectonic evolution of the Alps outside the scope of this paper.

TRÜMPY (1960, p. 882) summarized the basic content of the criticisms of embryotectonics that he and some of his Alpine colleagues had developed as follows:

"The criticism of the theory of embryotectonics refers to the paleogeographical configuration of late Triassic, Jurassic, and early Cretaceous time. In Argand's original concept, crustal shortening by tangential compression had already set in during the late Paleozoic. Later authors have postponed the onset of embryonic folding to the Triassic or to the early Jurassic. But in the new interpretation of Alpine pre-orogenic history, the structural pattern of the geosyncline in the Jurassic and Cretaceous is ascribed essentially to radial or tensional stresses."

The new interpretation of Alpine paleogeographic development separated an earlier (late Triassic to early Cretaceous) extensional phase from a later (late Cretaceous to the present) compressional one. Although Argand had recognized the extensional origin in the Triassic and later extensional evolution through the Jurassic of the Alpine geosyncline, he firmly believed that this evolution was interrupted by numerous compressional phases since the Lias. Other points in which he differed from the later views are his conviction that the remnants of the Hercynian geosyncline had been incorporated into the new Alpine geosyncline and his continued belief in the temporal and spatial persistence of paleogeographic units.

In conclusion, although after his 1934 revision of embryotectonics Argand came considerably closer to a "correct" view of the paleogeographic evolution of the Alps, he was still not as close as his critics were later. Today, newer views that portray the Alpine geosyncline as a dominantly strike-slip related mini-ocean (e.g. KELTS 1981) consider the possibility of local compressions throughout the evolution of the system and render parts of the post-Argandian views invalid, while resurrecting Argand's views on early compressive phases, albeit only partly and in a completely different interpretative framework. It remains, however, impossible to assess how much Argand really anticipated the current views, because he wrote so little. One could argue that because the data base that made our present understanding possible had not existed at the time, Argand could not have anticipated much. I am personally not so sure about that.

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