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## EMILE ARGAND 1879–1940. Life and portrait of an inspired geologist

By JEAN-PAUL SCHAER<sup>1)</sup>

### Introduction

A little over fifty years ago, Emile Argand died in Neuchâtel – a city where, as a professor, he had spent the greater part of his scientific career. Born in Geneva on 6th January 1897, this visionary of structural geology is perhaps Switzerland's only genius in this domain. Surprisingly, however, he remains little known beyond the world of geology. Even though they have not ignored other contemporary alpine geologists, encyclopedias such as the *Britannica*, the *Universalis* or the *Brockhaus* have not judged it necessary to include Argand who, together with Wegener, contributed more than anyone towards a clear global vision of geology, in advance of his time. For those who, like myself, did not have the good fortune to know Emile Argand during his lifetime, there nevertheless exists a great deal of excellent documentation published by his contemporaries and in particular by his pupils. The most outstanding and complete of these is without doubt that by M. LUGEON (1940), published soon after Argand's death. Professor of geology at Lausanne University, he was better placed than most, to offer a portrait of his former pupil. Lugeon had played a major role in confirming Argand's destiny as a geologist; he had loved his spiritual son although he was often obliged to tolerate his impulses and digressions. Over the years, he had followed his protégé's vision and watched it grow, and had seen him climb the echelons of national and later international acclaim before becoming established at the very peak of this hierarchy. Lugeon succeeded in portraying the essential elements of Argand's life both as a scientist and an individual. DUBOIS (1976) and WEGMANN (1970), who were both pupils of Argand at the period when their master was working on his major synthetic works, have proved to be valuable witnesses to both the man and the climate he created around him. At this level, it is without doubt the contribution of BOREL (1974), writer and critic, which captures most vividly his personality. He admired Argand for his vast culture and humanism which took him far beyond the intellectual world of the small provincial town where he liked to see himself as the prince of local philosophy. On Argand's death in 1940, the western world was basically preoccupied by the upheavals of the war. It is therefore hardly surprising that many major international geological journals did not mention – or only very briefly – this scientist, who several years previously in Brussels had succeeded in arousing the enthusiasm of his peers by giving a new global image of the earth and its evolution. The silence of the master

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during the later years of his life, plus the scepticism or even rejection of all notions of continental mobility which were gaining acceptance among geologists and geophysicists played a significant role in the silence which partially accompanied his death. The contribution by BACKLUND (1940), DAL PIAZ (1940), STAUB (1940), ESCHER (1940) and THALMANN (1943) are therefore even more touching. We should also bear in mind the bibliographical introduction which CAROZZI (1977) added to his remarkable translation of Argand's most outstanding work: *La tectonique de l'Asie*.

On the death of Emile Argand, his inheritor waived his right to inherit. All the master's personal papers were deposited at the Neuchâtel Institute of Geology where they rejoined the mass of scientific and administrative documents this scholar had accumulated. These major archives, of which a considerable part had not been filed, have now been organised and it is partly thanks to this approach that it has been possible to shed new light on certain points of the life and work of Argand.

### Early years

Emile Argand's youth was greatly influenced by the breakdown of his family life. The first and only child of a catholic Frenchwoman from the Savoie region and a humble protestant clerk, he suffered the painful consequences of a divorce which took place when he was only eight years old. It would appear that he spent the major part of his childhood with his father – a strange situation for the time.

He attended primary school in Geneva until the age of 12, and then completed this basic education by two years' training at the "Ecole Professionnelle", which he is said to have left with a good certificate. He then began work in a building company as a technical draughtsman, where he remained until 18 years of age. Letters to his mother from this period strongly evoke his solitude and his fear of the future. He despised his father's new wife and rejected the basically materialistic preoccupations of the society in which he was nevertheless obliged to live. Finding neither support nor affection there, although he was greatly in need of both, he was fortunate to encounter a group of young men of his age who enjoyed mountaineering and climbing expeditions and who appreciated his liveliness and strong personality. During this period, Argand read widely. In Geneva, his basic source was the public libraries; he was attracted by all he found and since the age of fifteen showed a marked interest in geology. On a professional level, it appears that he was appreciated. Aware of his value, it seemed to him that his future prospects were insufficient. It was therefore essential to break away from the path prepared for him by his father. His revolt was far-reaching, but took place calmly. Both his father and his employer accepted, perhaps against their better judgment, Argand's new plans for his future. These plans were still vague, but they were to lead him to the peak of his chosen career.

At this time, Madame Argand lived in Paris where she had opened a beauty parlour. This had later taken on the name of a massage and electricity parlour and finally become a beautician's salon. Argand, now twenty years old, wished to study in the French capital. Only the most prestigious institutions interested him: Ecole Normale Supérieure, Polytechnique, Centrale. He made enquiries as to whether his Swiss nationality could prevent him from gaining admission to these establishments. His mother informed him that without a baccalauréat it was impossible to be accepted.



EMILE ARGAND 1879–1940

(Photo by C.E. Wegmann, about 1920)



Argand then considered the possibility of opening, jointly with his mother, a salon like hers, only for men. He believed that such an occupation, which exploited human vanity and stupidity, would make it possible to earn enough money to do what he wished – geology. However, he abandoned this idea and decided to study for his Baccalauréat. From the beginning of 1901 he lived with his mother. After eighteen months of intensive work, with very little support, he caught up in every subject, including Latin, to take and successfully pass the Baccalauréat in classical studies (literature and philosophy) at the Faculty of Arts of the University of Paris. Still in Paris, he began to study medicine and passed his first examination. He then left France and continued his medical studies in Lausanne, starting again from the beginning since at that time, as now, no bilateral agreement on medical studies existed. The reasons for this return to Switzerland are not known. From his correspondence, we note comments which underline his nostalgia for the mountains and the difficulties he encountered in becoming integrated in French society, which he considered superficial and extremely competitive.

In Lausanne, having successfully passed his first examination in medicine, he had a major difference of opinion with one of his professors during his second year. Having met Maurice Lugeon, he left the faculty of medicine and turned to geology with astonishing ardour. He succeeded in this subject thanks to his self-taught knowledge which never failed to surprise his professors; this allowed him to handle, rapidly and without difficulty, the fundamental questions of the Pennine Alps which at the time constituted one of the central topics of the alpine range.

Since 1896, Argand had derived pleasure from alpine geology. He had read everything available on these subjects in Geneva's public libraries. In addition to what he read, he made numerous field visits, usually on Sundays. In 1902, just after passing his Baccalauréat, he travelled throughout the Alps of Valais and Piedmont with the aim of grasping their structure. On 2nd December 1904, at a time when he still considered himself as a student of medicine, he presented a talk entitled: "The origin of the Alps" to the Student's Society of Zofingen of which he was a member. It was an opportunity for him to show his affection for his homeland, at times with a certain degree of naïveté, and to show the close links between the geographical areas and their inhabitants. Already, the geological structure of the alpine range was his main interest, and in particular the vast overthrusts which had just been discovered.

### **Lausanne and first publications**

As early as 1905, after only one year of geology, Argand was co-signing his first notes with his professor; (LUGEON & ARGAND 1905).

These concerned the recumbent folds of the Pennine area. In this message, a bold and realistic structural vision of the internal zones of the Alps was presented for the first time which perfectly combined audacity and clarity of expression. The original manuscript of this work is preserved in Neuchâtel, which shows the writing to be that of Lugeon. However, it is highly probable that Argand's contribution was the dominant one both in the presentation of the major facts and the style of the notes. The exposé is dominated by a geometrical vision, and the volumes are perceived thanks to the axial plunges which characterise the entire architecture of the region. The synthesis of

thought which ignores detail is presented vigorously and without hesitation; it forces admiration when it does not provoke irritation because of the flawless assurance which it is advanced.

From this time onwards, Argand further intensified his research efforts into the Pennine area and particularly in the Dent Blanche nappe. Here, he was certainly attracted by the majestic site but also by the challenge represented by the cartography of these high peaks – one which he wished to physically conquer by deciphering the stormy history of their genesis. He was out in the field as soon as the spring weather permitted, and remained there without returning to the lowlands until he was driven out by the autumn snow. Over a period of six years, he spent more than 1,000 days above an altitude of 2,000 metres in the interests of geology, and cartography. At the beginning of May 1908, he submitted his hand-made version of the “Carte géologique de la Dent Blanche – ARGAND 1908”, to the Swiss Geological Commission. To this day, this work is considered as the essential work of reference on the region. It is immediately striking by its highly refined graphic presentation and the care and precision of the drawing. It was published with a rapidity which merits admiration; by the end of the same year 500 copies were issued. The speed with which this took place underlines both the quality of the manuscript given to the engravers and the support and goodwill its author enjoyed. At this time, nothing in the documents examined mentions the way in which Argand earned his living.

This leads one to think that he was still supported by his mother whilst trying to collect some payment for his scientific activities, such as colouring the geological relief of the Matterhorn on a scale of 1:50,000 issued by Imfeld (Lausanne and Zürich), plus his participation in university teaching by holding seminars. It is possible that Lugeon also paid him for various services rendered.

Argand submitted his doctoral thesis entitled: “L’exploration géologique des Alpes Penniques Centrales” in April 1909 (ARGAND 1909). This was full of information although relatively short. Again, it was immediately published. It contained 3 illustrations and a printed plate of profiles in series. Basically, the work presented the internal structure of the Dent Blanche nappe plus its links with the frontal Pennine zones. The author himself admits the preliminary character of his work. The various subjects are dealt with in a very unequal manner; some are presented in detail, whereas others are mentioned only briefly and left for a later date, even if the author considers them to be important. The text is precise, it allows the reader to follow the issues with a limited number of new facts remarkably well integrated. Often, however, his affirmations are derived from general reflections for which no justification can be found in the text. In his desire to create a synthesis, Argand is aware that the description and the cartography of his subject cannot be objective. A clear presentation demands simplification and imagination. It is nevertheless important to take this direction in order to grasp and render comprehensible the tectonic significance of such complicated structures. The strength of the message resides equally in the simplified vision and in the presentation of a number of carefully chosen details. The work accomplished by Argand in the Pennine Alps required considerable physical effort on the part of its author. Despite the fatigue, the frequent deprivation, the solitude and the cold, he registered in his prodigious and perfectly organised memory the details and the general lines which were useful both at the time but above all later, when creating the synthetic vision of a

large section of the alpine range. In the longer term, all this material and its geometry served to draw up the mobile image of the entire planet. Aware of the preliminary character of his work but also of the innovative aspects of his message, he noted the following extract from a newspaper. "We are the first pioneers. We are laying the foundations of an edifice which others will complete – and foundations always have something incomplete about them". When writing his thesis, Argand mentioned on several occasions that this first draft would be completed by a more detailed work which would serve as a justification and as a detailed explanatory note to his map of the Dent Blanche. During several of its meetings, the Swiss Geological Commission was to mention that such a manuscript had been submitted on several occasions, but taken back by Argand each time. It even agreed to publish this as quickly as possible. Within the archives of the Neuchâtel Institute of Geology, several hundred pages of manuscript exist which must correspond to this work. Argand intended to produce a large monography, illustrated with 12 profile plates, panoramas and some 50 sketches. When we examine the amount of work carried out by Argand in this direction, we are somewhat amazed that the author, who at the time was still young, never succeeded in completing it. Argand's comments on his difficulty in writing are given in a letter to P. Arbenz: January 10th 1916.

Pour m'arracher au travaux d'érudition, il faudrait me tuer. Quant à écrire vite, c'est une autre affaire; si je n'y puis parvenir, je le dois en grande partie à la déformation du liseur professionnel et à la capacité même avec laquelle je puis repenser tout l'atlas que j'ai dans la tête. Comme sûreté et comme étendue, cet atlas est bon, mais il se déroule beaucoup trop vite pour la main, qui ne peut pas suivre; je n'ai pas écrit la dixième partie d'une phrase que ma pensée est déjà à la fin de l'alinéa, ou même du chapitre. Les idées sortent d'ailleurs en ordre irréprochable, et du premier coup; mais quel travail pour les retrouver quand la main est prête! C'est une chasse d'où je reviens presque toujours bredouille. Pour retenir, saisir et rassembler le gibier, il me faut des artifices incroyables. J'y parviens en concentrant l'esprit sur tout le chapitre, que je rédige mentalement et *en entier* dans ma tête, jusqu'à le savoir par cœur, comme une leçon apprise; arrivé à ce point, j'écris automatiquement et vite. Cela suppose, toutefois, un esprit reposé, à l'abri de tout dérangement extérieur, et maintenu dans cet état pendant les journées qu'exige la concentration.

There is no doubt that part of the ideas prepared within this project were used in later works, but the analyses, sketches, and the petrographic descriptions which had required many days of microscopic observation, never came to light. Aware of imperfections, Argand certainly preferred to abandon this publication rather than associate his name with a work which he judged important but still not perfect. Generally speaking, Argand experienced great difficulty in presenting detailed observations during this period, particularly those linked with the local structural analysis or the description of lithologic units. His attention was totally focused on the only concern of the moment, the general geometry of the Pennine units, which reveal the dynamics of the entire alpine range.

During these years, Argand still paid a great deal of attention to aspects of petrographic evolution, and particularly to metamorphism. He was aware that petrographic transformations go hand in hand with structural modifications. We should not forget that during 1909, he had a period of instruction under Professor U. Grubenmann at the Federal Polytechnic School in Zürich. This was probably a calculated move since a vacancy in this discipline was to come in Lausanne. Having abandoned this hope (see page 520), Argand decided not to pursue his research in this direction – a fact which is regrettable when we note his mastery of the subject. The manuscripts found in Neuchâtel show that even before 1910, among other things, he had identified with great precision the presence of lawsonite in the ophiolitic zone of Zermatt. This discovery was lost for more than 50 years (see BEARTH 1972).

### **General maps of the Western Alps**

From 1905, thanks to his intense cartographic activity, Argand attempted to draw up a synthetic map of the Pennine area. First of all came a manuscript document entitled “Carte tectonique des Alpes penniques au 1:250 000 par Lugeon et Argand”. This covered the Valais and Piedmont regions between the Rhône and the Aosta valley and from the St. Bernard to the Toce river. Later, based on two Italian topographical sheets on the scale 1:500,000, we see the first version of what was to become the map of the “Nappes de Recouvrements des Alpes Occidentales”. This document, signed by Emile Argand in Aosta on 25th September 1905 is quite remarkable, particularly when we bear in mind that its author had been involved in full-time geological work for barely a year. Despite this handicap, he had set down the contours of the Pennine units from the Grisons to the Mediterranean with a great deal of precision. Almost all the information for future works is already present. It is true that at the time, the prospect of establishing a coherent synthesis of the Western Alps appeared to be becoming ever closer. The work by LORY (1866), first of all, clearly demonstrated that this part of the Alps was made up of a series of longitudinal zones which, because of their lithologic content, had a distinctive character. Italian geological studies, including those by ZACCAGNA (1887), made it possible to create lithological maps which were relatively precise, even if based on false stratigraphic assumptions. The fundamental paleontological discoveries by FRANCHI (1898) helped establish order in this area based on solid stratigraphy and extend the zones for which good cartography exists. These works were further completed by those of Novarese and Stella. On the French side, thanks to research by TERMIER (1907) for the major part, profiles across the Alps were established. These are strongly influenced by the discovery of the major overthrusts recognised in Switzerland. When we add to all these results the fortunate consequences of the investigations in connection with the Simplon tunnel, we understand more fully that the time was ripe for a synthesis. Thanks to his perfect mastery of geometry and cartography, Argand's work on the subject immediately became the accepted version which for decades remained the basic work of reference on this large sector of the Alps. His success was linked to his in-depth knowledge of literature on the terrain, his fine judgment regarding the material he took from other authors and his mastery of stratigraphic and petrographic problems. His youthful audacity and the beauty of his drawing did the rest. This first attempt at a synthesis in 1905 was, however, to remain



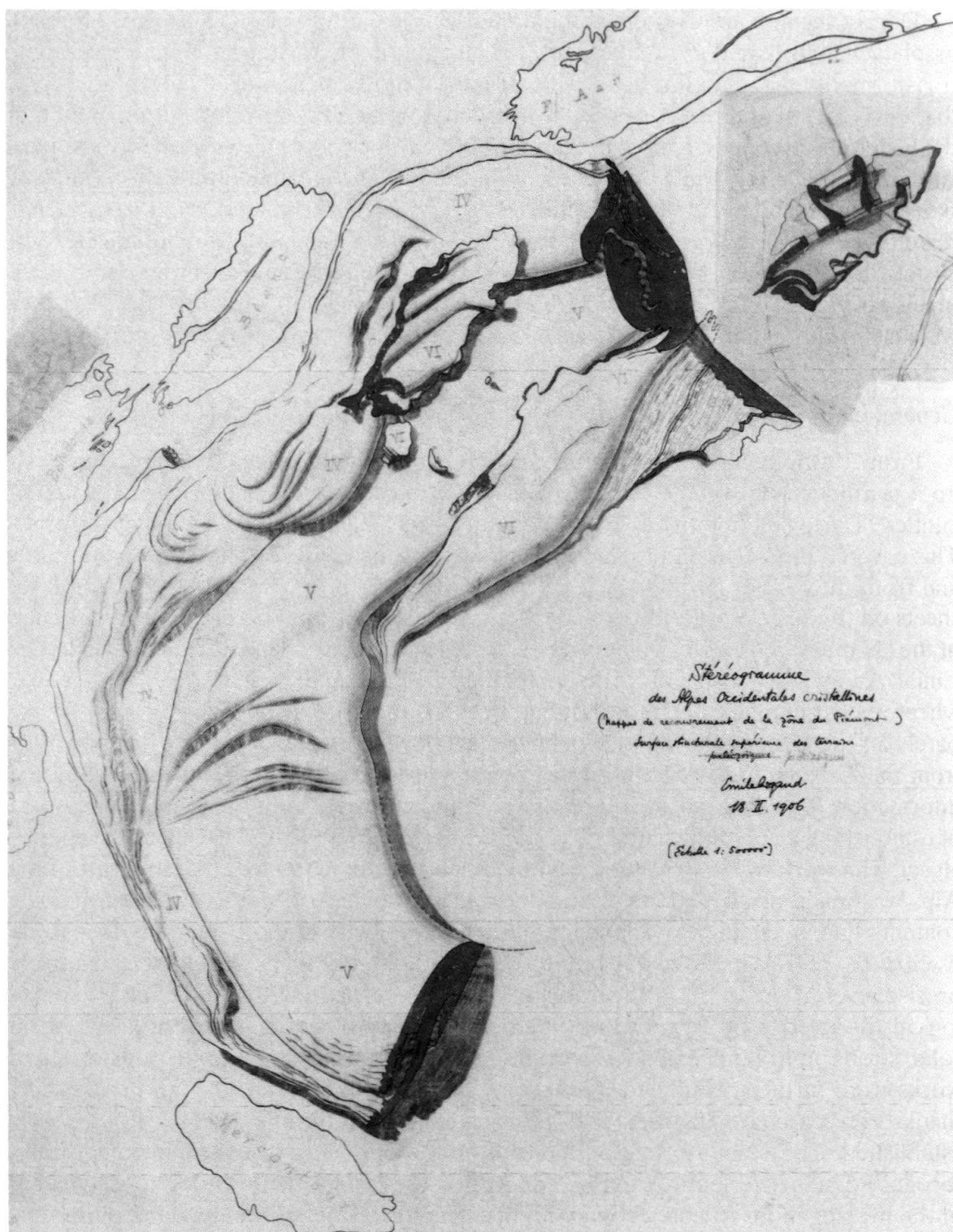


Fig. 1. An early hand drawing by Argand, of the internal and external structure (anatomy) of the Pennine domain. Drawn after his first year of exploration! Black ink, black pencil for shadows and red ink for the internal structure. Size of the original about 50 × 60 cm. To the upper right of the document, a small sketch of the Dent Blanche Nappe by Argand on the same scale, probably drawn the same year has been superimposed.



hidden for several years before being completed by the series of sections which facilitated the spatial vision (ARGAND 1911f).

Over the first months of 1906, Argand used the information he had gathered during previous campaigns to draw several elaborate structural sketches, where the internal anatomy of the cristalline units and their cover is thrown into relief by various graphical methods which provide the whole with a most striking three-dimensional impression of space (Fig. 1). None of this material has been published.

## Neuchâtel

1911 represented a turning point in Argand's career. The candidature which he had submitted and those he envisaged no doubt led him to increase the number of his publications and thus to pass on to the world of science the amplitude of results he had collected during his alpine investigations, which were continuing at an even greater rhythm than before. In his report to the Swiss Geological Commission at the end of 1910, he noted that he had spent 151 full days in the Pennine Alps, which had enabled him, apart from rest days and periods of rain, to spend 130 days on efficient and intensive work. In 1911, Albert Heim, who was 63 years old, requested retirement from his post as professor at the Zürich Polytechnic School. Argand submitted his candidature, but it was Hans Schardt, then professor at Neuchâtel, who was appointed. During the same year, Argand received an offer from Portugal to take up the post as a director of the Geological Survey. He hesitated but finally declined, since he had hopes of obtaining a kind of supervisory role and monopoly from the Swiss Geological Commission concerning all geological research envisaged in the Pennine regions of the Valais, Italy and France. Despite his insistence to Albert Heim, then President of the Geological Commission, he did not achieve recognition of his authority over this small kingdom. He then applied as successor to Schardt in Neuchâtel, where he was easily selected over some rather insignificant fellow candidates. He received the title of Professor to carry out teaching duties which were grouped together on Fridays and Saturdays, for in fact this was only a part time post. Schardt had supplemented this activity by working in secondary education in Montreux and by consulting. Argand began his activity in Neuchâtel by continuing close links with Lausanne where he maintained his principal residence. For a certain time he even replaced his master Lugeon, who had taken a leave of absence. In these two cities of the French-speaking region of Switzerland, Argand redoubled his activities. In Lausanne, he presented a series of communications to the Société Vaudoise des Sciences Naturelles and the Swiss Geological Society which were rapidly published in the form of brief but substantial notes (ARGAND 1911a–d). In Neuchâtel, he took charge of the geology laboratory with the firm intention of changing it into a modern and envied institution. The fundamental article on the recumbent folds in the Pennine Alps and their structural extensions was published in this same year of 1911. The presentation of the Pennine area in the Valais (ARGAND 1911e) was made via a map and block diagrams (Argand called these stereograms), which greatly facilitated the spatial vision of the entire sector. Through his analysis and the presentation of the plunging structure towards the SW, we are faced with a sort of preliminary study to the major work of the year, "La carte des Alpes

Occidentales", (ARGAND 1911f), accompanied by three plates of transversal and longitudinal profiles. This remarkable synthesis presented the author's vision of the structure of the Alps from the Grisons to the Mediterranean. The graphic and esthetic quality of the work are perfectly linked to the scientific accuracy; the details are so well integrated within the vision of the whole that they provide a highly coherent picture. His qualities of synthesis and his remarkable craftsmanship render the map and the profiles easy to read, and thus led it to be considered as a model of its kind, much admired but probably never equalled. By this work, Argand was able to put across perfectly his vision of this part of the alpine range which he felt had been created thanks to a process of continual deformation whose present form was its ultimate structure. Thanks to his use of the rules of strict geometric projection in a structure where axial plunges are important, it was possible to present, with sufficient precision, the form of the eroded sections in the updomed sectors as well as the structural profiles in the buried parts. For the first time in the world, the structure of some 40 kilometres of continental crust became apparent. For many geologists, this work represented a genuine milestone in alpine geology.

In 1913, Argand – although still only 34 years old – came to the attention of the entire scientific world. He was awarded the Spondiaroff prize, the major distinction presented by the International Geological Congress. Argand's entire work had certainly been taken into consideration during the jury's appraisal. However, it was his work on the recumbent folds of the Western Alps which was cited. This did not completely fulfil the conditions foreseen by the previous Congress which had chosen the topic "Critical studies on the theoretical bases of major thrusts". The members of the Prize Commission, felt that even if Argand's work did not contain a critical appreciation of the major thrusts, this theory "best explained the extremely complicated phenomena which can be observed throughout the alpine range... The presentation of these facts are therefore the equivalent of a critical study".

Despite some problems during the first World War, Argand successfully imposed his concept of creating the first real geological research unit at the extremely small university of Neuchâtel. In 1915, he managed to obtain a full position and a major increase in working space for the geology laboratory, plus a larger credit for the purchase of books and journals, the new arrangement of the scientific collections and of the library. The local authorities agreed to these expenses, since they feared that this young and dynamic professor would return to Lausanne, where there was a vacancy in petrography. However, Argand did not leave Neuchâtel. In the capital of the Canton of Vaud he received so little support from his former mentor that he was forced to realize that his presence was not desired. Argand was never to forget what he saw to be a failure and above all a betrayal. Relations with Lugeon never became as cordial as before.

During 1917, it was the turn of Geneva to call upon Argand to take up the chair of geology which had become open. Argand was unable to obtain a guarantee from his home canton and the city of his youth that he would be provided with working conditions similar to those in Neuchâtel, and above all those planned and later completed in 1919. At this time, despite the very few students attending geology courses in Neuchâtel – rarely more than four – he succeeded in having a new Institute of Geology installed in the renovated administrative buildings of the former cantonal prison, which

occupied a privileged position dominating the lake and the Alps. As was his habit, Argand invested his entire energy into this affair; he supervised every detail concerning the 23 rooms available for research, teaching and collections. He was able to persuade the authorities, his friends and philanthropists that Neuchâtel was on the brink of reviving its famous intellectual and scientific role which had been animated by Agassiz in the previous century, at the time when the first Academy had been created.

Argand spared no effort in this undertaking. He collected funds and took over the organisation of the collections, including those left by Agassiz, which unfortunately had been neglected for many years and were in a sorry state. Argand paid special attention to the library, which was to rival in size, quality and documentation the most prestigious international and specialised institutions. He drew up plans for this, and made contact with the major European libraries and institutions in the USA, in Japan and in China. Thanks to conventions drawn up with official institutions and local learned societies – which in some cases still drew benefit from contacts established by Agassiz – Argand was proud to note that his institute united some 200 scientific journals and some 11,000 books. He had created the background against which he wished to carry out his future research, and his own palace of science, so there was no longer any question of leaving Neuchâtel, apart from the time he devoted to field research work. His position as professor is presented in his letter to P. Arbenz:

Je me demande, à mon âge, quelle illusion je puis encore avoir. Je n'en ai plus, semble-t-il, sur le cœur humain. Je veux dire, le cœur des autres. Que me font les sept trônes, et les ambitions plus nombreuses que les trônes? A la réflexion, ils m'apparaissent bien dévernés. Illusion et désir, tout est mort; il me reste, à mes yeux, que sept sièges pour sept culs, et je me compte dans le nombre. Tout compte fait, le siège que j'ai convient à mon ... genre de beauté. J'y trouve les deux seules choses qui, à mon estime, valent la peine d'être voulues avec quelque énergie: 1) l'indépendance; 2) le moyen de m'instruire, de me mettre au courant des progrès des Sciences.

Sur le premier point, le passé m'a rendu intransigeant et intraitable; quant au deuxième, l'acquisition du savoir et la joie de le trouver, j'en fais le fond même de la vie, et je lui subordonne tout.

Argand liked to complain about his poor capacity as an administrator. In his letter to Paul Arbenz:

On s'accorde à me trouver tolérable comme savant, mais on ne sait pas assez que je suis nul comme administrateur, ou plus exactement, comme écrivain administratif. La paperasserie bureaucratique n'est pas mon affaire; j'en ai trop souffert entre 13 et 20 ans et j'ai gardé de cette époque une aversion douloureuse pour cette forme d'activité; dès qu'on me parle de ce genre littéraire, je sens remonter le souvenir odieux de ces années perdues, et je me retrouve tel qu'à l'âge de 20 ans et 8 jours, alors que dans un dur coup de tête, je voulais être un homme de science et fis sauter en une minute les projets que mon père et mon patron avaient conçus pour mon bonheur.

When we examine the integrality of the papers left by Argand at the Neuchâtel Institute, it is impossible to be totally in agreement with this judgement. Through his activity, his contacts, and the persuasion he used both orally and in writing, he was able – in a very short time – to transform a poor laboratory which occupied only two small rooms in the basement of the main building of the University to a partially independent Institute which was the first of its kind in Neuchâtel. The creation, but above all the management of such a structure demanded facilities and administrative support which Argand never received, or perhaps never requested. Solitary and demanding, he wished to be at the head of all initiatives and activities carried out by his institution. He needed total independence which led him to draft out personally, by hand, the inventories of the collections, the periodicals and the cards listing books bought or exchanged. He even went so far as to write, in his own hand, the index cards for new acquisitions, and wrote them in cyrillic characters if the work was so written. He launched himself into assembling and making an inventory of the documents left in Neuchâtel by Agassiz, plus those of DESOR, JACCARD, etc.; he envisaged the publication of unpublished material in a new and sumptuous collection. “In this way, the greatest hopes are possible and I am sure that if we take care, we shall never lack help. The AG-DES (Agassiz and Desor) tradition is more than simply a tradition, since it is still bearing fruit in a practical way today”. Argand was partially aware of the extent of the task which he had set himself. He believed that his need for independence, which he confused with his strength and enormous capacity for work, would allow him to overcome problems and to do so alone. “It is a certain fact that I can never be satisfied with existing organisations, whether these are institutes, libraries or collections. An existing organisation is a hindrance; in order for me to be interested, an organisation must express my thoughts and be my sole creation”.

Among his colleagues and friends in the sphere of administration, Argand had not met any personalities who had sufficient influence upon him to limit his ambitions or at least force him to complete certain projects before launching himself into new adventures. For this reason, many of Argand’s initiatives were never realized. The structures created and which were constructed on a solid basis did, however, stand the test of time; the institute, the library and the collections remained a respectable and even envied working tool, and underwent few major changes for several decades.

Sometimes, however, the difficulties encountered with the administrative authorities did provoke Argand’s irritation and his energetic mockery. In 1924, at the time when he was adding the final touches to the proofs of “La Tectonique de l’Asie”, and when one would have thought that all his energies were directed towards this absorbing task, he sent a typed letter, six pages long, to the Director of the Neuchâtel Electrical Services on the trivial matter of a projector lamp and a badly-adapted transformer. This was quite ridiculous, but quite apart from the satire it contained, which resembled the jokes Argand liked to play as a student, this seems to be a waste of time and energy, unless it was a necessary outlet for his mind at such a crucial time.

The troubled period of the first world war, the search for a satisfactory professional situation and the establishment of the institute did not seem to be a sufficiently heavy burden upon Argand to stem the flow of his creative thought. In 1916 he published the article “Sur l’Arc des Alpes Occidentales”, which was the continuation of a communication presented in Geneva at the meeting of the Swiss Geological Society. Based on



the geometrical structure previously established, Argand dealt with the evolution of the alpine range from carboniferous times to the present. The message contains two dominant ideas; that the deformation of the major Pennine units is discontinuous on all scales, but by integration of every movement a continuum is produced whereby matter flows like a viscous liquid. The source of general deformation is directly linked to the movement of Africa towards the coast of Eurasia.

The morphology of the seas and islands of the Far East provides striking analogical images of this evolution, since “these arcs in movement show us, side by side and at the same moment, the successive states recorded by mountain ranges which are more evolved but not necessarily more ancient. In a way which resembles that of comparative anatomy, the study of these ranges confirms the results of embryotectonics”. The unraveling of the structures makes it possible to place, in both space and time, the different paleographic areas of the geosynclinal zones. The image presented is a combination of strict but not continuous observation, integrated to form a whole which emerges at the level of a controlled imagination. The graphical presentation of this synthesis is of such a high graphic and didactic quality that the model rapidly became a classic and an essential basis for paleogeographical reconstruction. For several decades, it had more power than the facts collected in the field. With time and the evolution of ideas, it became apparent that the perfect and imaginative drawing was misleading. (See also TRÜMPY 1960). With considerable difficulty, Argand’s message was slowly discredited and finally replaced by a new paradigm which, like its predecessor, still has its limits.

### **Accomplishment**

De Margerie, who had the considerable merit of having translated “The Face of the Earth” into French and adding in-depth commentaries to it, wanted the scientific world to have at its disposal a full series of good geological maps of the world. It is highly probable that he had spoken of this with Argand on several occasions. Since he admired the latter’s memory, intellect and spirit of synthesis, he even went so far as to propose this project to him. Probably as a result of this encouragement, or perhaps because his horizons were reaching out ever further, Argand orientated his research in this direction at a relatively early stage. Neuchâtel possesses two original manuscripts in this connection. Firstly, there is a large wall map on a scale of 1:8 million, of geology and morphology, completely drawn by Argand’s own hand and entitled “Carte tectonique de l’Eurasie, 1912”. It covers the same area as the one presented to the Brussels Geological Congress (1923) only published in 1928. The style of these two documents is strictly the same; although the colours used in the first version are a little paler. Upon closer examination, one notes that Argand added more blank areas in the second version for those regions for which he did not judge the documentation available to be sufficient. As a younger man, his imagination had substituted the lack of facts. In some places, Argand’s new version modified details in order to take into account the latest research discoveries. The 1912 document proves that at that time, Argand had an extremely clear vision of the tectonics of Asia. In a second document, a planisphere on a scale of 1:30 million, signed and dated 1913, Argand used different shades to show the different fold belts of the world; alpine, cimmerician, hercynian,



caledonian and pre-cambrian. These two works are, in fact, the illustrations which preceded the written text, and demonstrate that Argand – the visionary architect – began by graphic expression before translating this into writing.

La Tectonique de l'Asie (ARGAND 1924), Emile Argand's major work, was first presented as a lecture at the Brussels International Congress. It was not an oratorial success (CAROZZI 1977). Argand knew that as usual, at such an event he would speak too fast. In his letter to Arbenz:

On m'a beaucoup reproché de parler très vite, mais il m'est aussi difficile de parler lentement que d'écrire rapidement. La difficulté est du même ordre, quoique un peu moins sensible dans le premier cas. C'est toujours la disparité entre la vitesse des trains d'idées et la lenteur de l'organe. Si je m'efforce à parler lentement, je ne puis finir mes phrases, et je me donne l'air d'un idiot. La conversation de Margerie me donne un plaisir parfait, parce que nos vitesses sont égales; il s'ensuit que l'intellection est instantanée; naturellement, son atlas est beaucoup plus étendu que le mien, et je donnerais bien des choses pour l'avoir.

The Brussels message was intended to be taken as a modification and extension of Suess' achievement, "Das Antlitz der Erde", envisaged in the perspective of Wegener's work on continental drift. As was the case for Suess, the earth as a whole was examined but with particular emphasis on Eurasia and the sedimentary basins which bordered its coastlines during the Mesozoic and Tertiary periods. The work is completed by a remarkable map which united, with perfect graphism, virtually all the geological information available at the time. Thanks to his prodigious memory and unceasing work, Argand was able to grasp the essential of everything published on the subject of these distant lands. He was not satisfied with simply juxtaposing elements from various sources, but sorted and integrated all of this into a united vision which was intended as an illustration and a defence of the theory of continental drift. As in his first field studies he succeeded in presenting only the essential. Like POPPER, he was aware that "the value of a theory lies entirely in the agreement between the consequences which can be deduced from it and well-observed facts" (p. 293) and that "The validity of a theory is nothing more than its aptitude to present all facts known at the time" (p. 292). On a regional level as on a general one, he was not seeking to prove anything (this term is virtually absent from his writing), but rather sought to show the integral strength of the mobilist theory, and all the strength it would lend to future exploration.

If Wegener had found arguments in favour of continental mobility within the Atlantic opening which were reinforced by paleographic reconstructions, Argand showed that classical tectonics – those with which the field geologist is faced – can be reconciled with Wegenerism. Current morphologies which can be seen on maps and in the landscape of the Far East are the modern expression of major thrusts recognised in ancient and modern mountain ranges. Vertical movements are not an independent category of dislocations. They are the results of horizontal displacements provoked by forces arising from continental confrontation. For decades, those who attacked the theory of continental mobility liked to refer to the physical principles which the drift mechanism implied, or to paleographic arguments. In both these domains, and particularly at this time, instinct and speculation were even more prevalent than today as

regards reliable information. Argand's coherent concept had the advantage of proposing one of the first global vision of the earth's deformation, never to be contested, and based on the presentation of concrete facts. This should have made scientific discussion with a solid base a possibility, but this was not the case, basically because Argand's argument implied a knowledge of regional geology which very few scholars mastered at the time. For this reason, both his theory and argument were virtually ignored by all those who did not wish to subscribe to Wegener's ideas, even if this new presentation had the benefit of showing the evolution of mountain ranges within a logical unity.

The work was not only a scientific revolution in orogenic theories; it also proposed a multitude of new and fruitful ideas in regional geology which are still modern today, but which only came to be accepted with time: the opening of the Gulf of Biscay, the rotation of the Corso-Sardinian unit, the individualisation of the African promontory (since renamed the Adriatic promontory), the advance of the Apennines on the African promontory, the oceanisation of the Mediterranean, the oceanic suture where Eurasia and Gondwana meet, and the thrust of Africa over Europe whereas India plunges under the Himalayas and Tibet.

### **Wegener and Argand**

The first French translation of Wegener's "La Genèse des Continents et des Oceans" by REICHEL appeared in 1924. Reichel was Argand's assistant at the time and GIGNOUX, professor of geology in Strasbourg. The latter was responsible for its presentation in the *Revue Générale des Sciences* (GIGNOUX 1925). His flattering article demonstrated the links which existed between Wegener's theories and Argand's ideas. Argand was only partially satisfied by Gignoux' article, and even wrote him a long letter which reveals the way in which he placed his approach as compared with that of the German scholar. This letter brings to light certain aspects of Argand's character, with its weaknesses and pretensions: (English translation of this letter in the Addendum at the end of this article).

Wegener est un esprit hardi et l'un de ses côtés forts, que vous relevez si justement, a été d'être assez au courant des ensembles géologiques et assez étranger aux détails pour débrouiller, à la lumière de la géophysique, un des nœuds les plus enchevêtrés du problème terrestre.

Je partage moins votre sentiment au sujet de la clarté dont vous êtes disposé à lui faire honneur. Ses œuvres de physique pure, d'astrophysique et de météorologie, où il est tout à fait chez lui, sont en effet remarquablement claires. Je ne saurais, sans des réserves qui porteraient sur plus d'un passage, en dire autant des ouvrages, d'ailleurs si originaux, qu'il a consacrés aux dérives continentales, encore que la marche à la clarté et à l'affinement soit évidente de 1912 à 1922. Mon sentiment est que «Die Entstehung der Kontinente und Ozeane» est entièrement clair une fois mis en français et que le mérite de cette clarté revient pour une part très notable à M. Manfred Reichel, qui a un sentiment délicat de notre langue et se meut avec une aisance presque égale dans les nuances complexes de l'allemand.

M. Reichel est mon assistant et la traduction a été faite dans mon laboratoire.

L'idée première de la traduction dérive des leçons que je fais régulièrement, depuis 1915, sur le *wegenerisme* mis en harmonie avec ma propre pensée, et non sans adjonction de résultats qui étaient alors inédits et le sont encore en partie aujourd'hui.

Les éditeurs m'avaient demandé de préfacer et d'annoter cette traduction. J'ai préféré m'en abstenir pour ne pas déflorer mes deux ouvrages «Des Alpes et de l'Afrique» et «La tectonique de l'Asie», alors en préparation, ...

... j'ai revu avec M. Reichel une grande partie du manuscrit de la traduction, et il est peu de pages dont nous n'ayons fait ensemble l'examen au triple point de vue du fond, des nuances de l'allemand et de l'ordre français.

Cette expérience et celle que j'ai eue, à dater de 1912, de chaque travail original allemand dès sa parution, ne sauraient me laisser de doute sur le fait que sur les obscurités assez nombreuses du texte ne sont véritablement débrouillées que dans la traduction française.

Les quelques passages que l'imprimeur de la traduction a embrouillés ne sauraient évidemment changer cette appréciation.

Je vous suis reconnaissant d'avoir bien voulu, en passant, signaler à vos lecteurs mon mémoire sur la tectonique de l'Asie. Sous le signe de l'Asie, c'est la planète entière que j'ai essayé d'embrasser dans une certaine vision, et peut-être y a-t-il, dans le conte que j'en ai fait, un peu plus que le langage de la théorie des translations continentales. Les trois quarts du mémoire, jusqu'à la fin du chapitre XXVI, sont construits non sur le *wegenerisme*, mais en prolongement de la tectonique classique. Le souci de l'objectivité, autant que celui d'innover en partant d'une base éprouvée, m'ont dicté ce parti. Les chapitres XXVII à XXX marquent la mesure dans laquelle, selon moi, la tectonique classique et le *wegenerisme* sont conciliables, et l'étendue des sacrifices que cette conciliation impose à la première et au second. C'est ainsi que l'un et l'autre m'apparaissent vrais dans leurs traits essentiels. Le raccord est indiqué dans la mesure où Wegener ne l'avait pas fait, tant pour les problèmes de la tectonique générale que pour des applications régionales, grosses ou menues, portant sur tous les continents et sur tous les océans. Les chapitres XXXI et derniers, intentionnellement abstraits, surmontent le *wegenerisme* et le ramènent à n'être, en définitive, qu'un cas important mais particulier, impliqué dans un des principes les plus anciens et les plus généraux de la tectonique classique.

Vous mettez l'accent sur ma vision du problème alpin et méditerranéen. Il y a là, comme votre disance le laisse transparaître avec raison, une optique particulière aux géologues de ce côté-ci de la planète. A l'échelle où je me suis habituellement placé, ce problème et celui des rapports de l'Eurasie et de la Gondwanie ne sont pourtant que de gros détails intéressants ...

L'idée du charriage de la Gondwanie sur l'Eurasie et celle de la formation des Alpides au cours de ce jeu, apparaît pour la première fois dans mon mémoire «Sur l'arc des Alpes Occidentales» (Eclogae geol. Helv. vol. XIV, 1916), notamment à la p. 163 et dans la fig. 15 avec son texte explicatif, sans parler des fig. à 13 et 17, évidemment liées au contexte précité. C'est donc une assez vieille trouvaille, à peu près tombée dans le vide en ce temps où le monde avait des soucis autrement graves et douloureux. J'affirmai, à ce moment, l'identité des nappes austro-alpines et des Dinarides avec l'indo-Afrique, d'où la conclusion dès lors exprimée, que les Alpes devaient leur origine au charriage de l'Indo-Afrique sur l'Eurasie et sur la Téthys.

Ma note «Des Alpes et de l'Afrique», rendue publique en juin 1924 et parue en tirages séparés au mois de juillet, étendait ces notions à tout le dispositif Eurasie-Téthys-Alpides-Gondwanie, de Gibraltar au droit de l'Inde. De plus, elle rendait compte de toute l'affaire par une vaste translation wegenerienne de l'Indo-Afrique vers le nord, suivie de distensions wegeneriennes. Je ne connais pas de travail antérieur dans lequel un géologue aurait nettement accepté le wegenerisme.

La «Tectonique de l'Asie», parue en septembre, est donc le *deuxième* travail que j'ai consacré à l'application du wegenerisme, et le *troisième* de ceux dans lesquels j'ai parlé du charriage de la Gondwanie sur l'Eurasie.

En choisissant et en opposant l'un à l'autre (Asie, p. 289) les termes de *mobilisme* et de *fixisme*, j'ai eu l'impression d'une délibération originale et non d'une réminiscence: c'est pourquoi j'ai souligné. Si vraiment cette manière d'écrire s'est rencontrée dans des publications antérieures à «La Tectonique de l'Asie», je vous serais reconnaissant de venir au secours de mon ignorance en me disant où cela se trouve, afin que je puisse à la première occasion, rétablir les choses ainsi qu'il conviendrait en ce cas.

## Time of Rest

After the efforts required to write “La Tectonique de l'Asie” and the preparation of the map of Eurasia, Argand appeared to distance himself from geology to a certain extent. As he had always done in the past, but in an even more evident manner, he became interested in everything which was published; in the arts, literature, philosophy, history, the history of religions etc. Traces relating to his expenditure on books proves that this was so high it accounted for up to 40% of his salary. His debts accumulated. Fortunately, in 1927, he was awarded the Marcel Benoist prize, the highest honour Switzerland reserves for its scholars. The large sum he received was, for the most part, used to pay his debts and to finance his travels. As early as 1934, Argand was again informed by his bookseller that he was once more in debt by Frs 3,200.—, which represented almost four months' salary. Among the works purchased either privately or for the Institute's library at this time, we find numerous titles on physics or geophysics. Rumour had it that during this period Argand wished to integrate geophysics within his approach of continental drift, in order to arrive at a more quantitative



modelisation of the phenomenon. This is possible as in 1919 he had already declared, according to THALMANN (1943) "Geology is a science of the past; the future is geophysics". The few notes which appear to confirm this hypothesis are too fragmentary for this to be certain. We are also partially surprised that no traces of correspondence with Wegener or other supporters of the continental drift theory can be found; here again, Argand is characterised by his solitude.

In 1934, to celebrate his fiftieth anniversary, the Swiss Geological Society published a guide to Switzerland. This includes introductions to various parts of the country by the leading specialists of the period. These texts were to be brief and submitted by a strict time limit. It was unthinkable not to designate Argand to write the text on the Pennine region of the canton of Valais. Argand had to be asked, begged and even threatened before finally supplying, well after the given time limit, a manuscript which, although concise, was a veritable treatise in which Argand had united his entire vision of the Pennine region of the Western Alps.

Despite the length of the text, this was fortunately published in full. For decades, it has remained an essential companion to all those working on these regions. Although its concept was not new, everything was united and perfectly balanced, with an outstanding presentation of geodynamic evolution ranging from the upper Paleozoic to the Tertiary period, with particular reference to the ambryotectonic of the Mesozoic seen within a geosynclinal framework. Several times, Argand mentions the presence of the decollement of the cover from the basement. However, he did not envisage this phenomenon becoming generalised and did not concern himself with the possibilities of cover substitution. On the contrary, he imposed – to an even greater extent than in the past – the permanence of triassic and liassic facies variations; the lack of continuity of these horizons were related to the opposition between comprehensive and differentiated series. The coherence of the vision presented was to be a stumbling block for future research, even though at the time, Argand presented a seemingly perfect framework within which there was ample opportunity for others to work.

### **Influence of Argand's message**

Reaching the end of this analysis of Argand's life and work, it would appear interesting to examine the ongoing effects of his work among his peers, before global tectonics became accepted. Regarding the structure of the Western Alps and the Alps in general, we can assume without hesitation that the synthetic and coherent vision of his works, supported by high-quality illustrations, convinced the majority of researchers. Over the years, modifications to his views were added – the fruit of field research but also of the modern development of science. These were able to clarify certain elements of structural evolution, but they did not change the general view so well presented from the outset.

On a level of his vision of the world and its evolution, we can almost maintain that the message within "La Tectonique de l'Asie" was neither understood nor heard with a few exceptions. Among these BAILEY (1926) closed his presentation of "La Tectonique de l'Asie" by saying: "Let us merely recall the advice given to young Darwin preparing for his voyage on the Beagle. Lyell's "Principles" had just appeared. "Get the book" said orthodox old Henslow, "study it, but don't believe it". Argand has succeeded in corre-



lating an enormous number of geological phenomena, and has thus given them a realisable unity. It may be wise, for the present, to consider his co-ordinating principles with a perfectly open mind; but this should not render us any the less grateful for the accomplishment of a singularly arduous and helpful piece of research". Written in French, in a poetic and complex manner which is sometimes even difficult to read for a native speaker of French, this work was only within the reach of a limited number of researchers. At most it was admired and respected for the mass of information it contained, and of which the Map of Eurasia was the synthesis. The message concerning continental mobility, supported by such a multitude of regional examples, had little influence for many years because ARGAND too frequently based his work on regions which, geologically speaking, were virtually unknown to the majority of his potential readers, who did not have his aptitude to integrate all the elements presented within their field of vision, even following Argand's commentary. Although the work included a magnificent map to support his text, there was very little clear and precise analytical background with the exception of details concerning the Mediterranean area.

In Neuchâtel, Argand made no effort towards forming a school which would carry on his vision of geology. He did not ask his pupils to illustrate and enlarge on his ideas. Feeling that his chosen topic was in advance of its time, he appears to have judged it impossible to associate his pupils with his work and limited himself to including them in studies of regional geology and sometimes astonishing them by lectures and magnificent drawings on the blackboard (see in LUGEON 1940). All this, plus his attitude to his students did more to widen the gulf between them and himself than to bring them closer together. In his letter of January 10th to Arbenz he expressed himself very clearly.

De même, le rôle de général sans armée me convient à merveille; les élèves font perdre beaucoup de temps pour rien; quand il sont intelligents, ils sont ingrats; quand ils sont reconnaissants, ils sont presque toujours bêtes; les exceptions à cette règle sont très rares. Je signe, avec un scepticisme parfait, les brevets de docteur; on a fait, en Suisse et ailleurs, un tel abus de cette denrée qu'elle est devenue sans valeur; l'indulgence aidant, il me suffit que le travail soit ni bon ni mauvais; quand il sort de l'ordinaire, j'en suis bien aise et presque surpris. A faire des cours, je m'amuse sans peine et sans enthousiasme; et puis – entre nous – ça ne sert à rien.

At that time, both the University and Swiss institutions lacked funds and it was therefore difficult to propose research subjects in distant but crucial regions. At the beginning of the thirties, a young Chinese – T.K. HUANG (future president of the Chinese Geological Society) – came to Neuchâtel to prepare his thesis. Argand immediately saw the advantages which could be drawn from this situation and invited his young pupil to travel to Crete, where he personally had probably never been, but where, as a visionary, he had situated the geological problems of the future. Huang could not accept this offer, since his sponsors in China demanded that he undertook a study of alpine tectonics, which he later completed. Huang was to become, through his writing, the pupil who was most successful in putting across his master's message – when he was able to do so. However, his activities had little influence in the Western

world because of the isolation in which he worked. Wegmann, another of Argand's pupils, began his geological research in the Pennine area. Highly influenced by the geometrical and structural approach of his master, he succeeded in demonstrating, in the course of his work on Scandinavia, the great utility of this approach in the study of crystalline areas. In combining Argand and Sederholm's new vision, he contributed greatly towards shedding new light on the evolution of the middle and lower crust of the earth, particularly in Finland and Greenland. The immediate impact of this approach remained modest on a planetary level as petrographers at that time showed a limited interest in structure and deformation on a continental scale.

### **Last comments**

Throughout his life, Argand led a basically solitary existence. Human feelings, affection and complicity which existed and developed with his mother and with other feminine influences in his life were, for this bachelor, merely a hindrance to the liberty he required for his research and his scientific activity. A study of his correspondence also reveals that he had probably made very few genuine friends, the exception being among geologists; Paul Arbenz and possibly Emmanuel de Margerie. The letters he sent to Arbenz between 1910 and 1920 reflect the harmony of two higher intellects and the intimacy between them. Even in these moments of communication, we see in Argand a need to stand out, to present himself as a personality; perhaps as he really was, but above all the image he wished to demonstrate and leave to posterity.

Prince of geometry and its application within natural sciences, he considered himself to be the only inheritor of the greatest of his precursors: E. Suess and M. Bertrand. He felt it to be his role to contribute towards taking geology out of the middle ages and propel it towards a stricter approach, where natural forces and their interplay could be dominated by superior intellects. In Neuchâtel, even more than within his contacts with the outside world, his comportment was a princely one. He preferred to reign over a small community which gravitated around him (colleagues, students, and admirers both masculine and feminine). This world which he dominated and which he never failed to impress by his prodigious culture was one he finally preferred to that of his peers, whose world could stimulate or perhaps contradict him. Among them, those who realised the potential of his memory and the strength of his creative imagination believed that it was still possible to push him to write further works, or at least complete those so often promised. Tired, perhaps, Argand preferred to travel for his pleasure (Spain, Morocco, Tunisia, Finland etc.), rather than to confront his ideas with the realities of regional geology. He intended to reign over his small local community, feeling that his presence in Neuchâtel had made this town the centre of geological sciences. By wishing to preserve his liberty in order to act, he became a prisoner of the personality he had invented for himself, and which escaped all stimulating criticism and new ideas: he now acted only with the aim of cutting a figure and not to create, and declined to use all the wealth of his intellectual potential which must nevertheless still have existed.

Sometimes, however, unfinished work, or perhaps requests from well-meaning friends or even memories of his field work led him to return to his beloved Alps. In particular, there was the geological map of Zermatt on which he had worked since

1905 and which he wished to complete one day as he had so often promised. He was convinced that his map was an expression of his synthetic vision which would allow him to make clear the structure and problems of this particularly complex but nevertheless significant zone of the Pennine area. In 1937, the map – finally considered definitive – was submitted to the Geological Commission to be printed. It was, however, taken back and re-submitted on several occasions. At that time, the Geological Commission was no longer ready and able to act with the same speed as it did in 1908 for the map of the Dent Blanche. In 1939, the war brought about new problems, and Argand's death followed. The map was never printed. For a long time, the location of the original was unknown. Rumours led to the belief that Argand, who feared the arrival of German troops in Switzerland, had decided to hide it under a large erratic boulder. In the seventies, like magic, the hand-drawn map so carefully prepared by Argand came to surface at the Geological Commission, where it had been maintained that it had never been deposited. This last work by Argand exists, but it will probably never be published since another map of this region was drawn and published by P. BEARTH (1953), who was not aware of Argand's version. The voluntary and involuntary actors within this minor drama are probably no longer here to explain to us the strange destiny of Argand's last scientific work.

In his private and public life – even taking into account the eccentricities with which he surrounded his personality – Argand appears as a solid member of the bourgeoisie, close to the institutions he criticised and complained about, but above all on the defence against the slightest alert from the outside world. On a scientific level, his physical capacities but above all his gifts as an observer and his sense of architecture, well served by a prodigious general and visual memory, allowed him to dominate space and volume and to play with them with ease and precision. Thanks to these gifts, to an outstanding capacity for work and to an unceasing intellectual commitment at the beginning of his scientific career, Argand succeeded in rising above virtually all other geologists of his time. His glory today rests on two essential aspects of his message; on the one hand the perennity of his cartographic and structural contribution in the Pennine area and on the other, his visionary's view of the structure and evolution of the mountain ranges and the earth as a whole. In the Pennine Alps, he was also able to pinpoint the majority of problems which were to interest his successors (facies variations of sedimentary rocks over time and space, petrographic diversity in the ophiolite suite, geometry of rock masses envisaged as the result of a pseudo-viscous matter, variation of the structural image according to scales of observation). In all these domains, his integral vision and his vast knowledge permitted him to propose models which are compatible with the science of his time, or even in advance of it. However, it is above all on a planetary level that his intuition, supported by immense bibliographic work, which enabled him to pose the questions of tomorrow; those which would be raised at a moment when the theory of tectonic plates would be accepted. Faced with the hypothesis which appeared to provide a united vision of the evolution of our planet, he attempted to use this model to grasp the structural modifications of the past and those of the future. He united all known facts and placed them in the new perspective. Filled with the vision which develops, expands and gains precision, everything suddenly became dazzlingly clear since he had observed the perfect harmony linking raw information and theory; his amazement at this could only be expressed by using a language

perfectly adapted to the situation. Without doubt, the message is not comprehensible to all, but this is of little importance to him since it had nevertheless been delivered. During moments of doubt, he was to rediscover this lofty strength which made him aware of his superiority – a strength which, on the threshold of maturity, had led him to leave a background which he felt unworthy of his capacities even though he found a certain security there. Later, he was to write: “I do not write for the distant future, but simply for the sake of truth, which cannot be dated as it has always existed.”

He knew that he could not be universally or immediately understood, but he wished to show that our planet was and is a sort of huge experimental machine. Those involved in tectonics must study in detail its internal geometry in order to discover the scenario which one day will make it possible to grasp the profound causes of its upheavals. As the spiritual son of Claude Bernard, he wrote in the preface of one of his unpublished works: “The precise observation of facts and their correct discussion are the only means by which we can broaden our knowledge. These form the only possible foundation of science and as such, they should be the only basis for the convictions of scholars. This, however, is far from the case. Time and becoming accustomed to new results play a role which is at least equally considerable. For this point of view, there are two kinds of truth within geological sciences. Firstly, there are those to which we are accustomed. And then there are the others. The first have the prestige of acquired results and appear to be incontestable. For many who are well-meaning, honest and reasonable, these constitute science in its entirety. And wise books only deal with these truths. As for my work, it will bear in mind both kinds.”

In conclusion, let us consider the comment made by Argand to his friend De Margerie on 3rd May 1912: “Nothing is more admirable nor more rare in a logician than the combination of rigour and daring.” Emile Argand has proved throughout his works, to a rare degree, that these two qualities can be united. This is the reason behind his greatness and his permanence.

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## REFERENCES

- ARGAND, E. 1908: Carte géologique du Massif de la Dent Blanche. 1:50 000 Carte spéc. no. 52. Comm. géol. suisse.
- 1909: L'exploration géologique des Alpes penniques centrales. Bull. Soc. vaud. Sci. nat. 45, 217–276.
  - 1911a: Sur la répartition des roches vertes mésozoïques dans les Alpes pennines avant la formation des plis couchés. Arch. Sci. Genève, Procès-verbaux de la Soc. vaud. Sci. nat. séance du 1er mars 31, 575.
  - 1911b: Sur les plissement en retour et la structure en éventail dans les Alpes franco-italiennes. Arch. Sci. Genève, Procès-verbaux de la Soc. vaud. Sci. nat. séance du 17 mai 32, 349–352.
  - 1911c: Sur la limite des deux séries cristallophylliennes compréhensives dans les Alpes occidentales. C.R. des séances Soc. vaud. Sci. nat. séance du 5 juillet. Arch. Sci. Genève 32, 358–360.
  - 1911d: Sur la tectonique de la grande zone permo-houillère des Alpes occidentales. Eclogae geol. Helv. 11, 747–751 et Actes Soc. helv. Sci. nat. 94me session, Soleure, Bd. 1, 265–266.



- 1911e: Les nappes de recouvrement des Alpes pennines et leurs prolongements structuraux. Matér. Carte géol. Suisse, n.s. 31, 1–26.
- 1911f: Les nappes de recouvrement des Alpes occidentales et les territoires environnants. Essai de carte structurale. 1:500 000. Matér. Carte géol. Suisse, n.s. 27, carte spéc. no. 64.
- 1916: Sur l'arc des Alpes occidentales. *Eclogae geol. Helv.* 45, 146.
- 1924: La tectonique de l'Asie. Conférence faite à Bruxelles le 10 août 1922. Congrès géol. int. (13<sup>me</sup> session). C.R. de la 13<sup>me</sup> session, fasc. 1, 171–372. Liège: Vaillant-Carmanne, 1924.
- 1934: La zone pennique. Guide géologique de la Suisse. Soc. géol. suisse, Basel, Wepf, 149–237.
- BACKLUND, H.C. 1940: E. Argand. *Geol. fören. Stockholm Förh.* 62, 408.
- BAILEY, E.B. 1926: Structural features of the Earth. *Nature* 2955, 863–864.
- BEARTH, P. 1954: Zermatt: Carte géol. 1:25 000 (Atlasblatt 29). *Comm. géol. suisse*.
- 1973: Gesteins- und Mineralparagenesen aus den Ophiolithen von Zermatt. *Schweiz. mineral. petrogr. Mitt.* 53, 299–334.
- BOREL, P.L. 1974: E. Argand. In: *La symphonie intérieure*: vol. 3, 131–160. Neuchâtel, Ed. H. Messeiller.
- CAROZZI, A.V. 1977: Emile Argand: Tectonics of Asia. Transl. and ed. by A.V. Carozzi. New York: Hafner; London: Collier Macmillan. (Titre original: *La tectonique de l'Asie*).
- DAL PIAZ, G. 1940: E. Argand. *Bull. Soc. geol. Ital.* 59, 125–126.
- DUBOIS, G. 1976: Emile Argand. In: *Naturalistes neuchâtelois du XX<sup>e</sup> siècle*. 99–100 (Cahiers de l'Institut neuchâtelois, Ed. de la Baconnière).
- ESCHER, B.G. 1940: Emile Argand. *Geologie en Mijnbouw*. 2. Jg. 12, 271–272.
- FRANCHI, S. 1898: Sull'età mesozoica della zona delle Pietra Verdi nelle Alpi occidentali. *Boll. R. Com. Geol. It.* 29, 173–247 and 326–482.
- GIGNOUX, M. 1925: Les théories de Wegener. *Rev. gén. des Sci. Paris*, 36, 139–142.
- LORY, CH. 1866: Coupes géologiques de la Maurienne et de la Tarentaise. *Bull. Soc. géol. France*, (2) 23, 480–497.
- LUGEON, M. 1940: Emile Argand (Bibliographie 1905–1937). *Bull. Soc. neuch. Sci. nat.* 65, 24–53.
- LUGEON, M. & ARGAND, E. 1905: Sur les grandes nappes de recouvrement de la zone du Piémont. *C.R. Acad. Sci. (Paris)* 15 mai.
- REICHEL, M. 1924: A. Wegener: La genèse des continents et des océans Trad. par M. Reichel. Paris: Albert Blanchard. (Titre original: *Die Entstehung der Kontinente und Ozeane*).
- TERMIER, P. 1907: Sur la nécessité d'une nouvelle interprétation de la tectonique des Alpes franco-italiennes. *Bull. Soc. geol. France*, (4) 2, 411–432.
- THALMANN, H.E. 1943: Memorial to Emile Argand. *Proc. Geol. Soc. Amer.* 1942, 153–165.
- TRÜMPY, R. 1960: Paleotectonic evolution of the Central and Western Alps. *Bull. Geol. Soc. Amer.* 71, 843–908.
- WEGMANN, C.E. 1981: Argand, Emile: Dictionary of scientific biography. New York: Chs Scridner's Sons.
- ZACCAGNA, D. 1887: Sulla geologia delle alpi occidentali. *Boll. R. Com. Geol. It.* 18, 346–420.

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## ADDENDUM

Wegener is an audacious character and one of his strong points, as you so rightly mention, was to be fairly familiar with geological ensembles and sufficiently unfamiliar with the details to decipher, in a geological light, one of the most knotty problems of earth.

I am less inclined to share your opinion as regards his clarity to which you pay tribute. His work in the field of pure physics, astrophysics and meteorology, where he is completely at home, are admittedly remarkably clear. With the exception of a number of sections, however, I cannot say the same for his works on continental drift even though they are so original. Nevertheless, his clarity and refinement is evident from 1912 until 1922. My impression is that "Die Entstehung der Kontinente und Ozeane" is perfectly clear once it has been put into French, and that this clarity is to a great extent thanks to Mr. Manfred Reichel, who has a fine feeling for our language and handles the complex nuances of the German language with ease.

Mr. Reichel is my assistant and the translation was carried out in my laboratory.

The original idea of this translation comes from lessons I have been giving regularly, since 1916, on Wegenerism as linked with my own approach, not without the addition of results unknown at the time and partly so even today.



The editors asked me to write a foreword and to annotate this translation. I preferred to abstain from doing so, not to take off the fascination of novelty of my works “Des Alpes et de l’Afrique” and “La tectonique de l’Asie” which were in preparation at that time ... with M. Reichel I have read a large part of the manuscript of the translation, and in fact there are very few pages which we did not examine together from a triple angle of the basic message, the nuances in German and those in French.

This experience, plus my own, with every original work published in German as of 1912, leave me with no doubt that the rather numerous obscure points in the original text are only really deciphered in the French translation. The few passages which have been thrown into disorder by the printing-office of the translation cannot change this appreciation.

I am grateful to you for mentioning incidentally to your readers my work on the tectonics of Asia. Using Asia as an example, I tried to unite the entire planet within a certain vision. Perhaps there is a little more in this story I have created than the theory of continental drift. Three quarters of the work – as far as the end of chapter XXVI, are not constructed on the basis of Wegenerism but as an extension of classical tectonics. The desire for objectivity and equally that of innovating on an established basis were behind my actions. Chapters XXVII and XXX demonstrate the extent to which, in my opinion, classical tectonics and Wegenerism can be reconciled and also shows the extent of sacrifices which such a reconciliation imposes on both. The last chapter, No. XXXVI, which is intentionally abstract, surmounts Wegenerism and definitively reduces this to an important but particular case within the most ancient and general principles of classical tectonics.

You stress my vision of the alpine and Mediterranean problem. Here, as your text rightly suggests, it is an option particular to geologists on this side of the planet. At the scale upon which I usually work, this problem and that of the links between Eurasia and Gondwana – however major and interesting – are only details ...

The idea of the thrust of Gondwana over Eurasia and that of the formation of the Alpides during this process appeared for the first time in my work “Sur l’arc des Alpes Occidentales” (*Eclogae geol. Helv.* vol. XIV, 1916), on page 163 and in Fig. 15 with its explanatory note, not to mention Figs. 7–13 and 17, obviously linked to the above context. This is therefore far from being a new discovery but rather one which was virtually forgotten at a time when the world was undergoing more serious and painful problems. At the time I confirmed the identity of the Austro-alpine nappes and the Dinarides with Indo-Africa, from which I came to the conclusion which I expressed at the time that the Alps owed their origins to the thrust of Indo-Africa over Eurasia and the Tethys.

My note “Des Alpes et de l’Afrique”, published in June 1924 and which appeared in separate printings in July, extended these notions to the entire area of Eurasia-Tethys-Alpides-Gondwana, from Gibraltar to the Straits of India. In addition, it dealt with the whole affair by means of a vast Wegenerian translation of Indo-Africa towards the North, followed by Wegenerian distensions. I know of no previous work in which a geologist clearly accepted Wegenerism.

“La Tectonique de l’Asie”, published in September, is therefore the *second* work which I devoted to the application of Wegenerism, and the *third* in which I speak of the thrust of Gondwana over Asia.

In choosing to oppose one against the other (Asia, p. 289) the terms *mobilism* and – *fixism*, I had the impression that this was an original deliberation and not a reminiscence; it is for this reason that I underlined the words. If it is true that this way of writing has been found in works prior to “La Tectonique de l’Asie”, I would be grateful to you to come to the assistance of my ignorance by telling me where this can be found in order that I may, at the first opportunity, put matters to right in the most correct way.”