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# The various figures of Mountains in Humboldt's Science and Rhetoric[1]

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*Abstract: Though mountains are mentioned almost everywhere in Humboldt's narratives, none of his writings was specifically dedicated to mountains as a type of landform, milieu, or category of knowledge. Aiming to contribute to a greater understanding of Humboldt's worldview, this essay strives to explain why mountains are valuable as objects his reflection. It points to the frequency with which Humboldt mentions mountains in his writings, the various scientific perspectives evoked in these references, and the overall coherence of his observations and perspectives.*

The published writings of Alexander von Humboldt include extensive books, essays, lectures and letters. Though mountains are mentioned almost everywhere in his narratives, none of his writings was specifically dedicated to mountains as a type of landform, milieu, or category of knowledge. Similarly, although many scholars have written about Humboldt, very few have focused on the role and place of mountains in Humboldt's writings. Where mountains have been addressed, their discussion has typically been limited to specific regions [2].

This essay aims to contribute to a greater understanding of Humboldt's references to mountains and how they were part of his project and rhetoric. It strives to answer a simple question: for Humboldt, why are mountains valuable as objects for reflection? I will point to the frequency with which Humboldt mentions mountains in his writings, the various scientific perspectives evoked in these references, and the overall coherence of his observations and perspectives.

## 1. "a unity in diversity of phenomena"

At first glance, mountains in Humboldt's writings seem to be a set of natural entities among many others. This is not surprising coming from someone who constantly expressed a curiosity for very different kinds of things. In the famous letter that he wrote to Schiller in 1794, when he was 25, he listed the botanical questions alone, which were then agitating his mind. These included:

> *...the general harmony of form; the problem of whether there was an original plant form, which is now to be found in thousands of gradations; the diffusion of these forms over the surface of the earth; the diverse impressions of joy and melancholy that the world of plants evokes in sensitive men; the contrast between the massive rocks, dead, immobile (and even the trunks of tress which*

[1] This paper was edited by Daniel Hoffman who, beyond this linguistic input, made many relevant suggestions on its content.

[2] See for example, Buttimer 2010 and Zimmerer 2006.

> *seem inorganic) and the living carpet of vegetation which, in a sense, delicately covers the skeleton with a more tender flesh; the history and the geography of plants, that is, the historical description of the general extension of plants over the surface of the earth which is an unstudied part of the general history of the world; the investigation of the oldest primitive vegetation to be found in those funerary monuments (petrifaction, fossils, carbon mineral, coals); the progressive habitability of the earth's surface; the migrations and journeys of plants – social plants and isolated plants – with the use of maps in this; which are the plants that have followed certain people? a general history of agriculture; a comparison of cultivated plants and domesticated animals, the origin of two degenerations; which plants more or less strictly or more or less liberally abide by the law of symmetrical form; the return of domesticated plants to a wild state (American plants as well as Persian ones – wild plants from the Tage to the Oby); the general confusion in plant geography caused by colonization. (quoted in Godlewska, 1999, p 244-45)*

The list is impressive in its variety. It also reveals the depth of Humboldt's scientific ambition. Notably, all the items refer to general phenomena, none to a specific kind of milieu or landscape form. Mountains are absent.

Humboldt's curiosity, which some readers found excessive and confused, was driven by a vision of integrative knowledge, "*unitary*" as he often said himself, holistic as we would say now. In fact, we should keep in mind that though his methodology was highly influenced by the French Encyclopédistes, and aimed at stating a huge number of facts, he was mainly curious about the relations between these facts, and between observations of details and the phenomena which link them. In the introduction to Kosmos (Cosmos), his stunning, and very personal synthesis of natural knowledge of his time, he wrote: "*The principal impulse by which I was directed was the earnest endeavor to comprehend the phenomena of physical objects in their general connection, and to represent nature as one great whole*" (Humboldt, 1877 (1845), I, p VII). Let's also recall that in Cosmos, nature should be understood as a set of elements and a field of forces which are structured by harmony, as suggested in this often-quoted sentence from the introduction:

> "*Nature considered 'rationally', that is to say, submitted to the process of thought, is a unity in diversity of phenomena; a harmony blending together all created things, however dissimilar in form and attributes; one great whole animated by the breath of life*" (Humboldt, 1877 (1845), I, p 24).

This idea was already evident forty years earlier in his Essai sur la Géographie des Plantes (Essay on the Geography of Plants): "*The overall equilibrium which exists throughout major perturbations is the result of an infinite range of mechanical forces and chemical reactions all of which balance each other*" (Humboldt, 2012 (1805)).

There was nothing in Humboldt's conception of the world and the structure of his interests, as revealed in his writings, that would have led him to develop a particular focus on mountains. Any single fact, or single class of objects, mountains as others, is less important in Humboldt's writing than the way he can connect it to the huge ensemble of related phenomena. However, from his earliest writings to his last, from 1790 until 1859, mountains are constantly mentioned and play a major role in his descriptions of his experiences, his method, and his vision of the globe. On several occasions, he points directly to the

significance of mountains, such as in the introduction of a volume of etchings of Andean volcanoes:

> *The configuration of great mountain masses, the great diversity of the contours of the high summits, situated like the lower lands in the midst of the agitations of the atmospheric ocean, are amongst the elements that constitute what we might call the physiognomy of nature. The aspect of mountains contributes no less than the form, the size, and the grouping of plants, nor less than the different species of animals, the nuance of the celestial vault, and the intensity of reflected light in determining the character of a landscape and the general impression made upon man by the different zones of the earth (Humboldt, Volcans des Cordillères…, 1854, p6)*

An explanation of this attention to mountains could be sought via several directions: in his early walks through several regions of the German *Mittelberge* and in the Alps; in his geological training at a time when the formation of mountain ranges was a major topic of theoretical discussions; in the influence of landscape aesthetics and Naturphilosophie with which he was very familiar, especially thanks to his familiarity with pre-romanticism and his deep friendship with Goethe. However, these perspectives aim at looking for explanations in sources external to Humboldt's academic writings, in his personal life, or in some kind of *Zeitgeist*. This essay will not proceed this way. I think that there is an internal coherence which informs the centrality of mountains in Humboldt's vision and rhetoric, and which underlies the variety of ways Humboldt mentions mountains in his writings. Framed this way, this paper will present various "figures" of mountains, referring to the various ways Humboldt shaped his descriptions, drawings, and analyses of mountains within his scientific project. The range of these figures will be the subject of the sections that follow. Finally, at the very end of the text, I will identify what unites these figures within his all-embracing conception of nature and landscape.

## 2. Lexicon: mountains everywhere but never defined

One of the tasks assumed by Humboldt was to understand the general shape of the continents and the internal configuration of their surface features. His method entailed a fairly common typology of landforms: plains, plateaus, hills, mountains, valleys, etc. He did not appear much concerned with defining these terms; more important for him was to explain that the significances of these features was best understood by viewing them in context. In Cosmos, thus, he writes:

> *"The portions of the earth's surface which we term plains are nothing more than the broad summits of hills and mountains whose bases rest on the bottom of the ocean. Every plain is, therefore, when considered according to its submarine relations, an elevated plateau" (Humboldt, Cosmos, 1877 (1845), I, p287)*[3].

Terms for landforms are conceived by Humboldt less as classes of natural objects, but more as categories of knowledge.

Alexander von Humboldt was highly interested in languages, perhaps an influence of his

[3] By the way, this idea is quite old. It is highly developed in Philippe Buache's work, published at the middle of the 18e century, which is discussed in the next section of this paper.

brother, the famous linguist Wilhelm von Humboldt. He was also interested in the meaning and etymology of place-names. His reflections on these, however, rarely appeared motivated by a wish to classify landforms or to treat them as natural entities[4]. When talking about languages, he was mainly trying to understand the diffusion and the differentiation of human beings on the surface of the earth. He was also interested in how the meanings of words used by people reflected their relations with their environment and their perceptions of the landscape. These concerns, for example, appear in his writings when he analyzes ways of naming categories of landforms in different languages (Humboldt, 1843, I, p 58-9) or when he discusses the etymology of Chimborazo (Humboldt, 1850 (1849), p 250); when he questions translators in order to understand variations in place-names found on Chinese maps[5]; when he suggests that it could be better to keep place-names used by indigenous people instead of Spanish names[6]; and when he notes that some place-names, such as Ural, connote different places for local people than for geographers and cartographers (Humboldt, 1843, I, p 472). Here and there, Humboldt also recommended names which, in his view, corresponded better to his own topographical observations. After discussing the various meanings given to the Altai and Atlas mountains in the earlier literature, Humboldt observed that some names,

> *"applied to the configuration or topography of the earth's surface, and invented at a time when one could only obtain a very uncertain knowledge of the land and its hypsometric relations, gave rise to numerous and enduring mistakes in geography. The ancient Ptolemean names Great and Little Atlas are such examples (…) The opinion according to which there is a Great and a Little Atlas is as little founded, as I have shown above, as the one which distinguishes a great and a little Altai. There is only one Atlas range" (Humboldt, 1843, I, p. 247).*

Though he endeavored to identify and name specific natural entities, Humboldt appears to have been little concerned with defining a systematic vocabulary for describing landforms or building a set of natural categories. He is thus quite different from many of the scientists of his time (see Oerlemans 2002). Correspondingly, the word "mountain", appearing in so many paragraphs of his work, is used in an open, and, at times, even vague manner.

### 3. Backbones: Mountains and the "configuration of the earth"

A first descriptive figure of mountains for Humboldt was to identify their geographic relationship to major river basins within the general topography of a continent. The story of his travel on the Casiquiare river, and the lessons he drew from it, are a good illustration of this approach.

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[4] However, he does write about the various ways of naming categories of landforms in different languages. One example would be the short section, in *Asie Centrale*, where he compares topography lexicons in Greek, Chinese and Sanskrit. (Humboldt*, 1843,* I, p 58-9)

[5] Throughout his *Asie Centrale,* Humboldt is highly grateful to Stanislas Julien, a famous sinologist of his time, who helped him in the reading and understanding of place-names found on Chinese maps.

[6] As he suggests for the Cayambé: "*The French Academicians named this colossal mountain, Cayambur, instead of Cayambe-Urcu, which is its real name; the word urcu denoting, in the qquichua language, mountain, as tepetl in Mexican, and gua in Muysca*. » *(Humboldt* 1814b (1810), II, p 99).

***Travelling up the Casiquiare river: a critic of hydrographic theories***

Soon after he landed in Cumana, in November 1799, at the outset of his South American journey with Aimé Bonpland, he navigated to the upper reaches of the Orinoco and Rio Negro. If we were only to read what was published later in his *Relation historique of the Voyage aux Régions Équinoxiales (Personal Narrative*…), we would see that he was curious about diverse things – the nature of rocks, the variety of tree species, the density of the Amerindian population, cases of anthropophagy, the temperature of running waters, the forms of cocoa trees, the presence or absence of mosquitoes, the appearance of stars when the leaf canopy overhead allowed room to see the sky, etc. – while Bonpland was mainly busy collecting and describing plants. One of the main objectives of this first expedition, however, was to understand the arrangements of landforms, springs and watersheds. More precisely, Humboldt wished to see if there was any kind of mountain range between the watersheds of the Orinoco on one side, and of the Rio Negro on the other. And to find an answer, the two would have to travel to the remote hinterland where the watersheds met.

In fact, even before setting out, Humboldt was already convinced that such a mountain range didn't exist. He had read many records made by explorers, missionaries, and Spanish administrators and none of these mentioned any significant range of hills or mountains. Moreover, it had been said that a river, called the Casiquiare, connected the Rio Negro and Orinoco river basins:

> *"No one in these missions for half a century past had doubted the existence of communication between two great systems of rivers; the important point of our voyage was confined therefore to fixing by astronomical observations the course of the Casiquiare, and particularly the point of its entrance into the Rio Negro, and that of the bifurcation of the Orinoco" (Humboldt, 1866 (1814), V, p 399)*

However, geographers and cartographers, following authors of the early and mid-18$^{th}$ century, maintained the contrary. The idea of a fluvial connection between the two great river basins was unthinkable for those who believed that watersheds were invariably delineated by mountain systems. Humboldt was familiar with their maps and arguments. After an arduous trip up the Orinoco, he traveled overland to the Rio Negro, but then from there returned to the Orinoco by boat, via the Casiquiare, which indeed bridged the two massive watersheds. His aim was to prove that these geographers and cartographers were wrong, and he especially targeted the famous French geographer, Philippe Buache[7]. Buache had given shape to the most famous and influential theory relating the location of river basins to mountain ranges. Humboldt, who knew Buache's publications and sometimes was influenced by them (see footnote 4), recognized their importance. He mentions Buache as "*a man of science, whose labours have been so useful to the progress of geography*" (Humboldt, 1866 (1814), V, p 496). But Humboldt disagreed with his vision of the field. In his Personal Narratives, he mentions Buache's

> *"*Carte Generale de Guyane*, published in 1798 (where) the Casiquiare (is) marked as a tributary river of the Rio Negro, and as not being connected with the Oroonoko. A chain of mountains is made to pass across the plain, and is supposed to run toward the north-east, and form a point of partition between the waters of the Oroonoko and those of the Rio Negro and the Casiquiare, twenty leagues west*

[7] For a comparison of Buache and Humboldt's conceptions of mountains in scientific knowledge, see Debarbieux, 2008b.

*of Esmeralda" (Humboldt, 1866 (1814), V, p 497).*

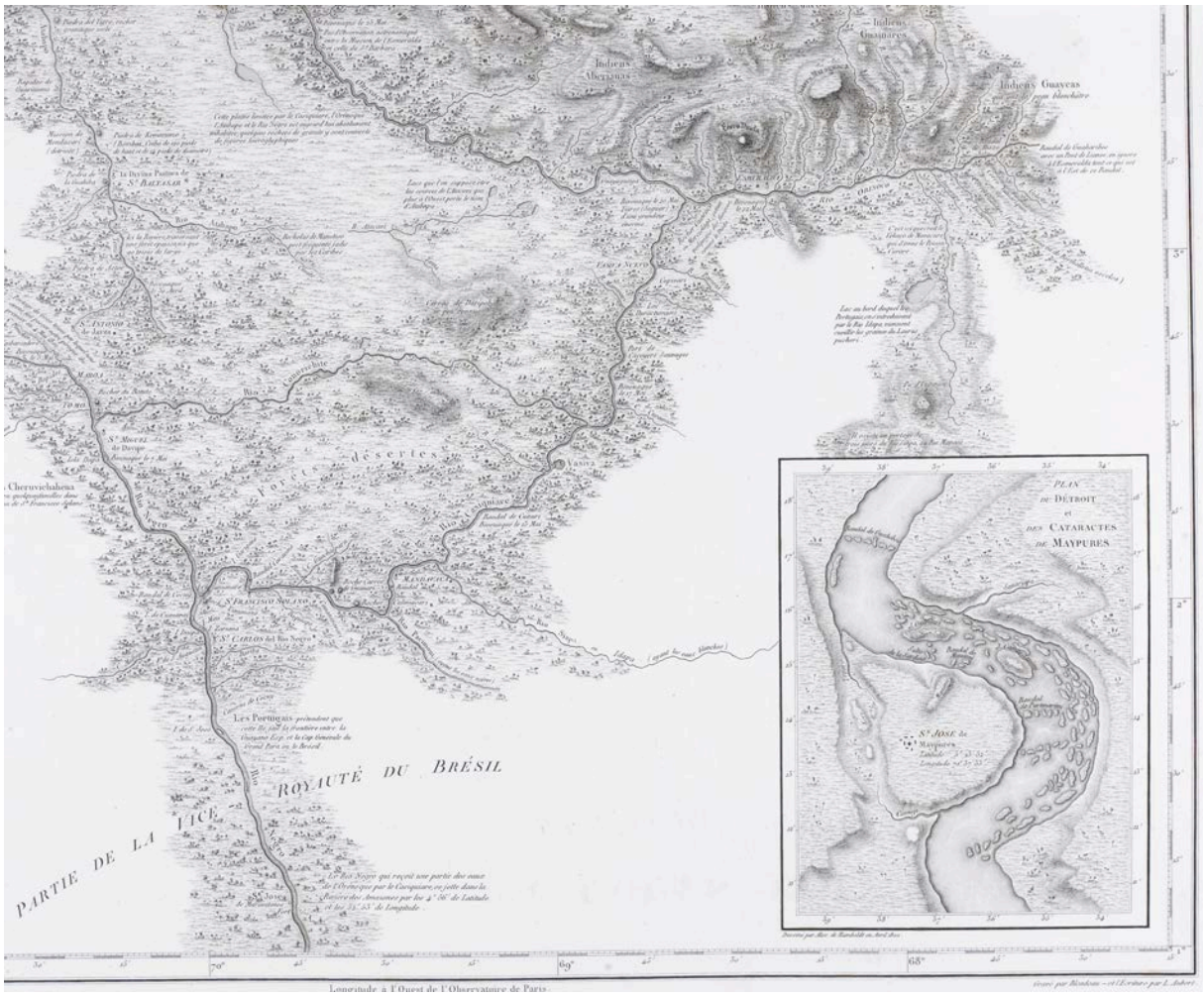


Illustration 1: Itinerary map of the course of the Orinoco, the Atabapo, the Casiquiare and the Rio Negro, showing the bifurcation of the Orinoco and its connection with the Amazon River (detail)] Source: Atlas géographique et physique du nouveau continent, 1814, Paris, F. Schoell

Humboldt adds that, written on this same map, there is a note by Buache asserting that

> *the long-supposed communication between the Oroonoko and the Amazon is a monstrous error in geography, which the map of La Cruz has multiplied, without foundation; and that to rectify the ideas entertained on this point, it is necessary to observe the direction of the great chain, which separates the waters (Humboldt, 1866 (1814), V, p 497).*

Humboldt reports then, with irony:

> *"I was fortunate enough to reconnoiter this chain on the spot. I passed with my boat in the night of the 24th of May, along that part of the Oroonoko, where Mr. Buache supposes the bed of the river to be cut by a Cordillera" (Humboldt, 1866*

*(1814), V, p 497)*[8].

Humboldt's navigation of the Casiquiare was not motivated only by his wish to see for himself what marked the division of the rivers. Humboldt was eager as well to definitively state who was right and who was wrong, and to give his readers the means to verify his assertion. He took measurements for making a precise map of the area (ill. 1) which would include details and anecdotes from the journey, and he measured the geometric coordinates of the exact place of the bifurcation of the Casiquiare: "*3° 10' of north latitude, and 68° 37' of longitude west of the meridian of Paris.*" (Humboldt, 1866 (1814), V, p 461-2) This evidence allowed him to criticize his colleagues' Eurocentric views and their ill-founded writings about tropical regions they had never visited:

> *"Accustomed to consider the rivers of Europe only in that part of their course where they are contained between two lines of ridges [*lignes de faites*], consequently enclosed in vallies; and forgetting, that the obstacles which inflect both the tributary streams and principal recipients are less frequently chains of mountains, than small risings of counter-slopes; we find a difficulty in conceiving the simultaneous existence of these windings, these bifurcations, these communications of rivers in the New World". (Humboldt, 1866 (1814), V, p 450)*

The voyage on the Casiquiare became foundational in Humboldt writings for several reasons. First, it influenced his conception of the articulation of mountain ranges and river basins. Second, the journey to the Casiquiare became emblematic of the virtues he saw in fieldwork and of the weakness of "*armchair geographers*"[9]. Third, it led him to promote a different approach to river systems, emphasizing local observation as the necessary foundation for comparative analyses:

> *"It is through intimate knowledge of the influences of variations in the terrain, of the melting of snow, of the periodic rains, and of the tides, on the on the flow, the winding course, the narrowings and the bifurcations, and on the outlets of the Danube, the Nile, the Ganges, and the Amazon, that a general theory of rivers may emerge, or better said, a system of empiric laws that encompass that which has been found in common or analogous between local and partial phenomena". (Humboldt, 1823, p 63).*

Thanks in part to Humboldt's travels in the Rio Negro and Orinoco river basins, the understanding of the localization of mountain ranges has been definitely dissociated from

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[8] In other publications, Humboldt is less ironic, but more critical of this kind of 'armchair geographers,' and gives a broader view: "*A knowledge of the great valleys or of the basins, an examination of the points where rivers take their rise, are certainly extremely interesting to a hydrographical engineer; but it is a false application of the principles of hydrography, when geographers attempt to determine the chains of mountains in countries of which they suppose they know the course of the rivers. They suppose that two great basins of water can only be separated by great elevations, or that a considerable river can only change its direction when a group of mountains opposes its course. They forget that frequently, either on account of the nature of the rocks, or on account of the inclination of the strata, the most elevated levels give rise to no river, while the sources of the most considerable rivers are distant from the high chains of mountains. Hence the attempts which have been hitherto made to construct physical maps from theoretical ideas have never been very successful*." *(*Humboldt, 1811, p lxxxvii and lxxxvii)

[9] Echoing the critics he received for having discussed Buache theory, such as the one made by Pinkerton in his *Modern Geography*, he writes "*this may be the fate of travellers who reveal facts that are contrary to taken-for-granted views".* (Humboldt, 2012 (1805))

the cartography of watersheds. For him, knowledge concerning mountain masses cannot be deduced from maps or a distant imagination, but rather, only by close observation, comparison and induction.

***Putting mountains on the map***

The 5 years Humboldt spent in America (1799-1804) gave him the opportunity to build his first synthetic representation of the distribution of mountain ranges at a continental scale. A comparison of his topographical descriptions in his Personal Narratives on the one hand, and the vast synthesis given in the Political Essay on the other, clearly shows how he worked to join detailed personal observations and investigations with existing information in maps and publications to build an overall vision of the spatial arrangement of major landforms in America.

The account of his second major journey, which led him to Central Asia in 1829, is even more revealing. He had been invited by the Tsar to visit Western and Southern Siberia and the surroundings of the Caspian Sea, in order to provide an account of the region's topographical features and mineral resources. This gave Humboldt an excellent opportunity to compare the topography of the American continent to that of Asia, and to refer to both of them in a global vision on the position of mountain ranges. His method highlighted his initial ideas regarding the usefulness of mountains toward a scientific understanding of what he called "*the physics of the earth*".

The starting point of Humboldt's argument in Asie Centrale is written in very simple words: "*In order to get a precise idea of the true physical constitution of a continent, and to understand the character of its topography, one needs to know the general relations between plains and upheavals which intersect or extend parallel to one another*" (Humboldt, 1843, I, p XIX-XX). To apply this approach, he used methods similar to those he had deployed for the Andes: he traveled, mainly in Ural and Altaï, and took copious notes; he absorbed the existing travel and early scientific literature, leaving aside those works, "*dogmatic and careless*" (Humboldt, 1843, I, p XXII, then again p 155), which he deemed unreliable. The rest, he compared with empirical evidence and specialists of local languages. At the end of his treatment, he gives his personal vision of the general topographical structure of the region, comparing the complexity of the system of mountains located east of the Brahmapoutre, which he did not visit, with the more simple system located between this river and the Caspian Sea. There, west of the Brahmapoutre river, he recognizes four systems, "*parallel to the Equator*" - the Altai, Thian chan (or Monts Celestes), Kouenloun (or Hindou-kho) and Himalaya - and four "*meridian*" (north-south) ranges – the Ural, Kousneck, Bolor and Soliman Mounts, as he calls them. Informed later, in the 1820's and 1830's, of the discovery of ranges higher than the ones he had visited himself, he progressively felt able to give an overall description of the mountains of Asia, with the Himalaya at its pinnacle.

Humboldt thus observed, as had others before him (such as Leopold von Buch and Elie de Beaumont), that Asian ranges for the most part followed an east-west direction, as did most ranges in Europe. In contrast, mountain ranges in the New World were mostly north-south oriented. He also pointed to another difference. While most major Asian ranges were located close to the center of the continent, their American counterparts remained close to the oceans, those located on the Atlantic side being much lower than those located on the Pacific (Humboldt, 1843, I, p 98).

Mapped properly, with the help of parallels and meridians, mountain systems constituted, according to Humboldt, fairly geometrical arrangements, which he depicted at various scales, for example in his map of Central Asia as well as in smaller maps such as for the volcanoes of the Quito region (ill. 2). This simplification of the continental configuration of mountain ranges does not emanate from any belief in a higher principle of agency, or in mathematical laws, as was the case with, for example, Buffon. In Humboldt's work, trigonometric measures were merely empirical tools with which to generate accurate maps.

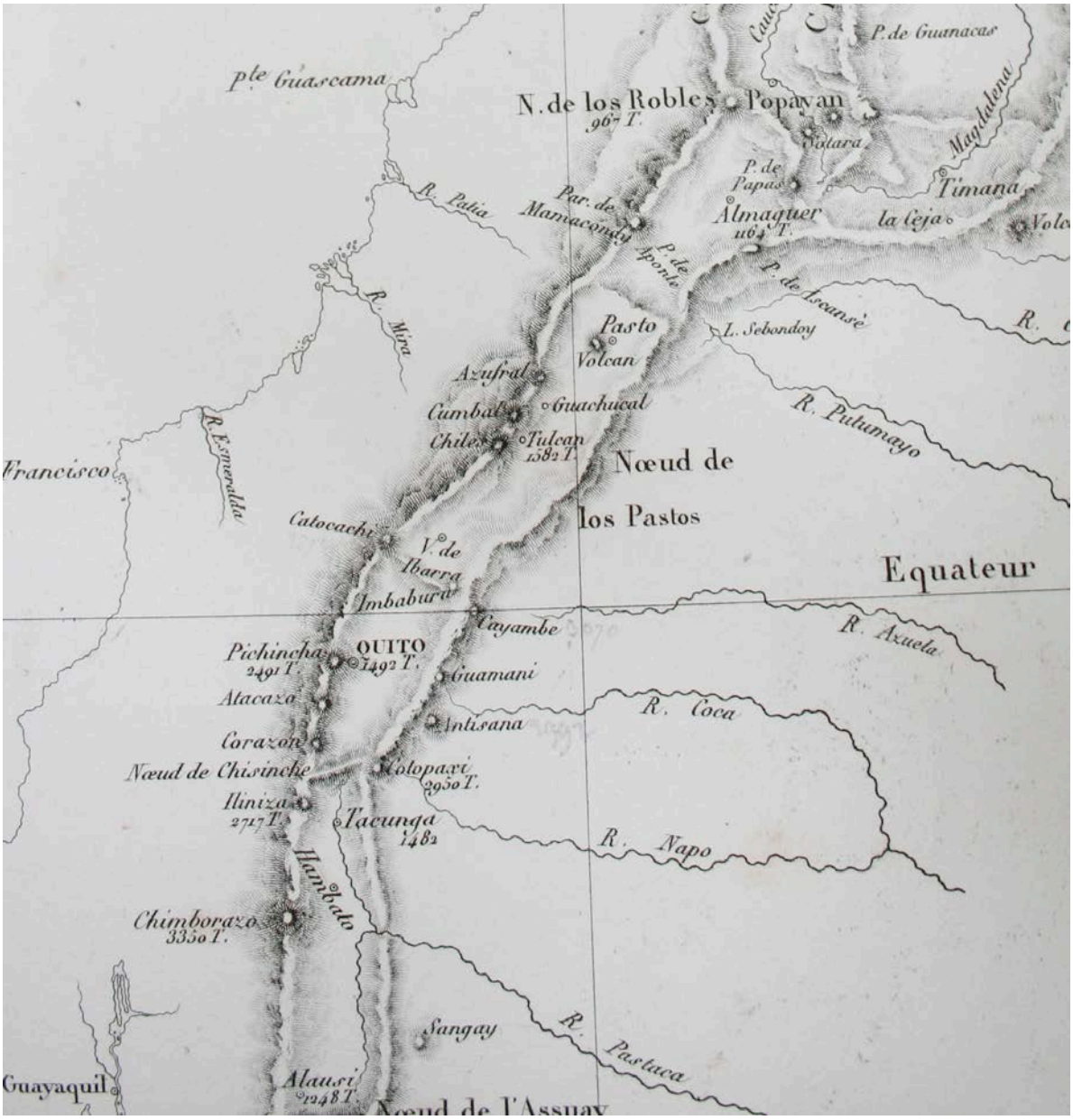


Illustration 2: Elevational diagram of the mountain nodes and branches of the Andes cordillera (detail) - Source: Atlas géographique et physique du nouveau continent, 1814, Paris, F. Schoell.

***Measuring mountains***

In America as well as in Central Asia, Humboldt devoted considerable time to measuring the altitudes of the main summits. He estimated the height of hundreds of peaks and drew several "*tables of heights*" (tables des hauteurs), which allowed him to put together the measurements made in distinct and distant places around the world[10]. Where he did not take the measurement himself, he relied on the work of other scientists, or asked them to assist him in transforming his barometric observations into tables of heights. For example, in his introduction to his Essay on the Geography of Plants, Humboldt recognizes M. Delambre, who "*agreed to enhance the Tableau with several hitherto unpublished altitudinal measures*" and M. Prony, who calculated "*a good number of my barometric observations (…) following the Laplace formula, but taking account of pressure. This respected scholar has kindly agreed to check with his own eyes over 400 of my own measures of altitude*." (Humboldt, 2012 (1805), p.xx).

Isolated measures, however, were not in themselves so important for his general understanding of continental topography:

> *"I never ceased to recall that the absolute height of crest lines and of the main summits which have given such fame to the Himalaya, Hindou-Kho, and Andes of Bolivia and Quito, is a much less important phenomenon, from the perspective of a geologist, than the direction and crossing of chains, the age of the rock formations which compose them, the average height of the plains, and, in particular, the position of these plains in relation to the great swellings (intumescences) of the earth's crust*" (Humboldt, 1843, I, p XXXII-XXXIII)

He comes back to the same idea later in the same book:

> "*Hypsometric measurements, striking for ordinary people, are of little interest for the physics of the Globe when they focus only on main summits of a cordillera or on isolated peaks*" (Humboldt, 1843, I, p 52).

Writing this, he keeps in mind that major ranges, however impressive when seen from their base, remain small compared to the distances which exist between them. That is why he often compares them to "*wrinkles*" (rides) of the earth crust[11]. In a paper published in 1825, Humboldt proposed a morphological index for mountain ranges which includes the height of the main summits and those of passes[12]. He calculated the average elevation of these ranges, which could then be weighted according to their area and then compared with the extension of the plains surrounding them, leading him to an estimate for the mean elevation of each continent, which he curiously named their "*center of gravity*"[13].

This way of thinking led Humboldt to develop graphic representations of mountains on detailed maps. Typically, he used both precise and simple depictions of mountains in order to make visible the precision (ill. 3) or vagueness (ill. 2) of the topographical knowledge concerning a range:

> *"The indication of the chains of mountains presented difficulties which can only be*

[10] Such as in *Asie Centrale* (Humboldt, 1843, III, p 233-251) and in the introduction of *Cosmos*.
[11] See as an example Humboldt, 1877 (1845), I, p 290.
[12] Quoted in Humboldt 1850 (1849), p 228.
[13] The mean elevations he finds are fairly low (Asia: 1132 feet; South America: 1152 feet; North America: 748 feet; Europe: 671 feet). See Humboldt, 1843, I, p 85 and 1877 (1845), I, p 301.

> *felt by those who have been themselves employed in constructing geographical maps. I preferred hatchings (hachures) in orthographical projection, to the method of representing mountains in profile. This last, the oldest and most imperfect of all, occasions, a mixture of two sorts of very heterogeneous projections. Yet I will not dissemble that this inconvenience is almost balanced by a real advantage. The old method furnishes signs which announce vaguely 'that the country is hilly, that there exists mountains in such or such a province'. The more vague this hieroglyphical language is, the less it exposes to error. The method of hatching, on the contrary, forces the drawer to say more than he knows, more than it is even possible to know of the geological constitution of a vast extent of territory" (Humboldt, 1811, I, p lxxxv).*

Locating mountain systems and measuring mountain summits and ranges in order to promote a general idea of the shape and topography of a continent are the first of several figures Humboldt uses when he focuses his attention on mountains. However, for him, this method in itself had limited scientific value. It was a preliminary step, only descriptive, prior to entering into truly scientific questions. The location of mountain systems is interesting as long as it is seen as part of an ensemble of clues revealing the internal structure of the earth, and in so much as it contributes to a global picture of fragmentation on the surface of the natural world. As stated in the Essay on the Geography of Plants, "*the spatial location and actual altitude of places influence everything in those regions which I traversed*" (Humboldt, 2012 (1805)). Therefore, Humboldt's curiosity about mountains is driven more by his will to understand cause-effect relations between various phenomena than by an imperative to create knowledge regarding to their locations and dimensions.

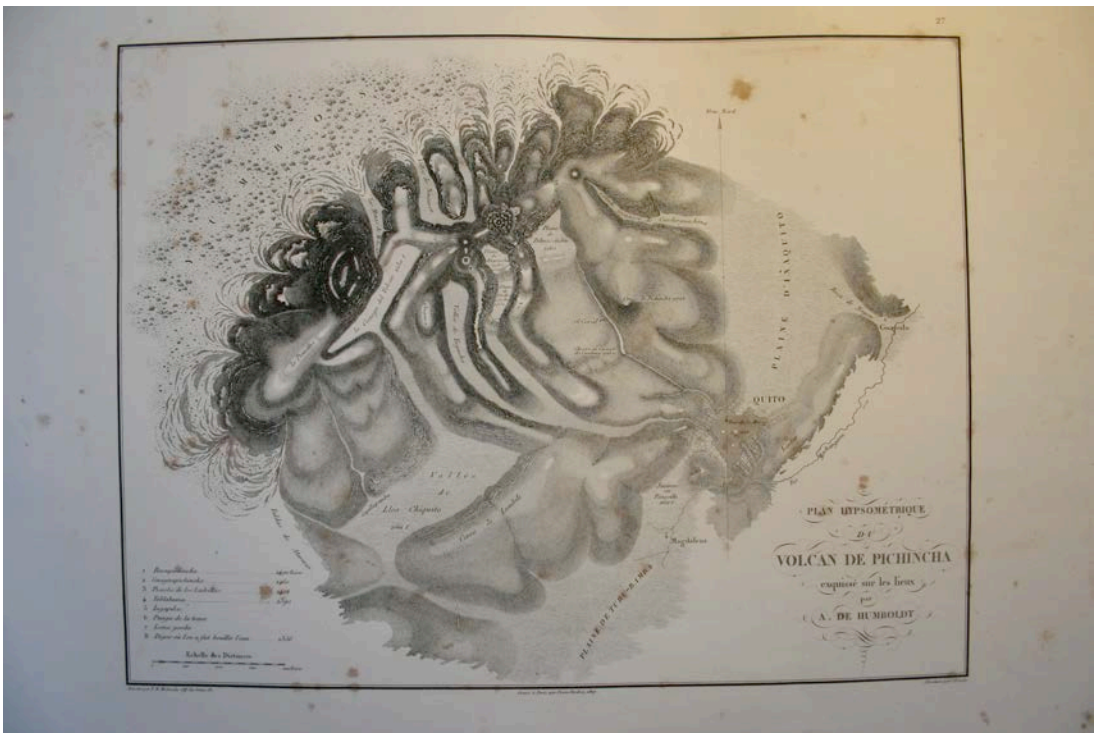


Illustration 3: Hypsometric map (and detail) of the Pichincha volcano

Source: Atlas Géographique et Physique du Nouveau Continent, 1814, Paris, Schoell

**4. Traces: Mountains and internal forces of the globe**

For Humboldt, the direction of mountain systems offered, first of all, indications of the structure of the globe: "*this phenomenon [mountains] offers one of the characterizing traits of the internal make-up of our planet*" (Humboldt, 1843, I, p 51). Among all Humboldt's scientific curiosities, this one was probably his oldest. He related it to his early training, especially at the Freiburg School of Mining where he was taught geognosy by Abraham Gottlob Werner, and to the time he was a geologist for the Prussian administration.

During the first half of the 19th century, theories on mountain formation were still tenuous and contradictory. The dispute between so-called Neptunists and Plutonists (or Vulcanists) was still stormy. Werner was one of the most influential Neptunists, but many of his students were more curious about the influence of internal forces and materials in the shaping of mountains and continents. Humboldt was one of them. He often recognized the influence he received from Leopold de Buch, whom he meet in Freiburg, and Elie de Beaumont, whose books on theories of orogeny he read and quoted frequently[14].

Progressively, as with many of his colleagues, Humboldt's explanations of mountain systems assigned more and more importance to "*internal planetary activity*" (Humboldt, 1877 (1845), I, p XIX) and, more precisely, to the "*internal heat of the whole Earth*" (Humboldt, 1877 (1845), I, p 179). Most mountain systems are said to be the result of huge "*faults*", or "*crevasses*" in the Earth's crust which have displaced "*portions of continents*" as a whole. The exact cause of these faults was not clearly identified. He often refered to the role of "*vapors*", or more precisely, the role of "*expansive force of elastic vapors*" (Humboldt, 1877 (1845), I, p 218) in the making of earthquakes. He suggested that water infiltration could feed this production of vapor, thanks to the proximity of the Ocean for the Andes, but also for regions which are far from the sea such as Central Asia. The importance given to vapors may have come from his fascination with volcanoes, particularly following his experiences in the Northern Andes, and perhaps from early studies made on the basalts of the Rhine valley in Germany. He related many geologic phenomena to what he called "*vulcanism*"[15], "*volcanism*" and "*volcanity*". Aware that volcanoes were absent in many mountain regions, Humboldt nonetheless attributed the formation of most mountain ranges to the liquid internal constitution of the earth. Furthermore, the action of these internal forces was not limited to the initial formation of mountain ranges but rather transformed them continuously:

> *"Where, by the elevation of mountain masses in the ancient corrugation or folding of the crust of the earth, access has been opened to the molten interior, that interior continues to act, through the medium of the cleft, upon the upheaved wall-like mass. That which we now call a mountain chain has not arrived at once at its present state: rocks, very different in the order of succession in reference to age, are found superimposed upon each other, and have penetrated to the surface by early formed channels. The various nature of the formations is due to the outpouring and elevation of eruptive rocks, as well as to the slow and complicated process of metamorphic action taking place in clefts filled with vapors and*

[14] For example, Humboldt quotes Elie de Beaumont 20 times in the first volume of *Cosmos*.

[15] "vulcanism, *in its broadest meaning of the word, designates all phenomena which depend on reactions from the internal part of a planet*" *(*Humboldt*,* 1838, p 42).

*favorable to the conduction of heat". (Humboldt, 1850 (1849), p 68)*

Though Humboldt's Essay on the Geography of Plants may seem unrelated to considerations of the internal constitution of the earth's crust, it contains several sections devoted to this question. Humboldt recalls that "*the formation and stratification of rocks tell us that the formation of mountains and crystallization of domes did not occur simultaneously throughout the earth*" (Humboldt, 2012 (1805)). Then, entering closer to the main topic of the Essay, he argues that "*plant geography must descend into the interior of the globe: there it can observe petrified monuments which nature has left in fossil wood and seams of charcoal - the graves of our planet's first vegetation*". This is what allows him to claim that "*the geography of plants can therefore enable one to confidently retrace earth history*" (Humboldt, 2012 (1805)).

Therefore, for Humboldt, as well as for many of scientists of his time, volcanoes and mountain ranges were active traces of the dynamic action between the earth's crust and the "*internal fire*". The orientation of mountain ranges at the surface of the continents was a clue for understanding the invisible structure of the earth's crust. Referring to the work of Adolph Erman, Humboldt explained that

> "*the direction of the great chain of the Aldan mountains in the east of Asia, which divides the streams flowing into the Lena from those which now flow towards the Pacific, if prolonged on the surface of the globe in the direction of a great circle, passes through several summits of the Rocky Mountains, between the parallels of 40° and 55°*"'.

Then, quoting Erman, he adds:

> "*Thus an American and an Asiatic chain of mountains appear to belong to one great fissure, following the direction of a great circle, or the shortest course from point to point" (Humboldt, 1850 (1849), p 56-57).*

However, if Humboldt constantly refers to the idea of force[16], especially for imagining what occurs beneath the surface of the earth, he remained helpless, as did most of his colleagues, in trying to explain what actually took place at such unseen depths.

Though Humboldt had been trained as a geologist, he did not make any decisive contribution to this field of knowledge. More specifically, he may have come too early, before the understanding of the formation of mountain ranges had attained its principal developments. His analysis may also have remained too general, too attentive to the interaction of natural phenomena, for deepening understandings of geological processes. However, when he focuses on the power of the internal heat of the globe and the connection between this heat, the surface of the earth and past and present vegetation, he is much more innovative. As we will see below, this is where his contributions in geology and the understanding of mountains are most interesting.

### 5. Partition: a proto-ecology of the earth's fragmentation

Compared to his contribution to geology, Humboldt's analyses on the effects of continental size and topographical features on the distribution of other natural phenomena is indeed much more important, and he often mentions this as his principal interest across his

[16] Forces of nature itself as well as forces which are said to lead humanity in its search for liberty. See Dettelbach, 1996 and 2002.

scientific work: "*my main objective has been to indicate these enduring features through which nature has been able to diversify the soil, climates and productions*" (Humboldt, 1843, I, p XI). This way of seeing combined his interests in the historical, genealogic, and geographic dimensions of his physics of the Globe. Within this synthesis, the manifest diversity of forms at the earth's surface is the outcome of a long chain of causes and effects related to the geologic formation and topographical structure of the globe. From this perspective, mountain ranges held great significance:

> *"Thus the awful revolutions, during which, by the action of the interior on the crust of the earth, great mountain chains have been elevated by the sudden upheaval of a portion of the oxidized exterior of our planet, have served, after the establishment of repose, and on the revival of organic life, to furnish a richer and more beautiful variety of individual forms, and in a great measure to remove from the earth that aspect of dreary uniformity which exercises so impoverishing an influence on the physical and intellectual powers of mankind" (Humboldt, 1877 (1845), I, p 299-300).*

Therefore, mountain systems are seen as sources of diversity for climates, for plant geography, as well as for the spatial distribution of human beings:

> *"the arrangement (*agroupement*) of mountains, in that they divide the surface of the earth into basins or vast cirques, as in Greece and Asia Minor, individualizes and diversifies the climate as regards heat, humidity and the diaphaneity of the air, and, in these respects, the frequency of winds and storms. These circumstances influence the range of crops, cultures, habits, institutional forms and national hates. Individual geographic character reaches, so to speak, its maximum, where the differences in the makeup of the soil in the vertical plane and the sinuosity of contours (the articulation of the flat surface) are simultaneously the greatest possible" (Humboldt, 1843, III, p 211-12).*

Within this framework, the comparison of topographical configurations in the various continents becomes a tool for understanding the nature, intensity, and distribution of the observed variety of forms. Coming back to the contrast between mountain systems of Asia and those of the "*New World*", Humboldt notes that the former, being organized along parallels, "*set apart climates and crops*," whereas alongside those of the New World, "*meteorological phenomena as well as phenomena of life, including human races, tend to blend and to cover vast areas in the meridian direction*" (Humboldt, 1843, I, p 96). Once again, his Essay on the Geography of Plants perfectly illustrates this way of thinking. The mountain ranges of North America have facilitated the migration of plants southward:

> "*The vegetation of Canada and northern regions has diffused toward the South and the volcanic mountains of Mexico are covered with the same kind of fir which should theoretically only be found at the headwaters of the Gila and Missouri*". To the South, "*all along the Andean heights, at elevations of 3000 m, there are Brathis juniperina, Jarava (…), Escallonia myrtilloides, several varieties of Molina, and especially Tourettia…*" (Humboldt, 2012 (1805)).

The Andes are also said to have facilitated the diffusion of peoples from the North to the South (see below). Humboldt notes that in Europe, by way of contrast, the Mediterranean Sea and mountain ranges which span from west to east, such as Pyrenees, have "*prevented the migration of African plants to southern Europe*".

According to this view, mountain systems are located at the very center of an ensemble of causes and consequences that Humboldt wishes to highlight. Born from the internal activity of the earth, mountains provoke spatial fragmentation and guide the differentiation of climates, vegetation areas, and peoples. They become a key feature of nature as a whole, and a key ingredient of its spatial and genealogical complexity.

**6. Cross-Sections : manifestations and consequences of altitudinal gradients**

Focusing on the locations of mountains on the surface of the continents and their geographical influence on plants and human beings, Humboldt adopted a broad view of natural phenomena, which he represented with maps covering wide areas. However, he complemented this perspective with a more intimate vision through detailed maps and drawings, which were decisive to his scientific renown.

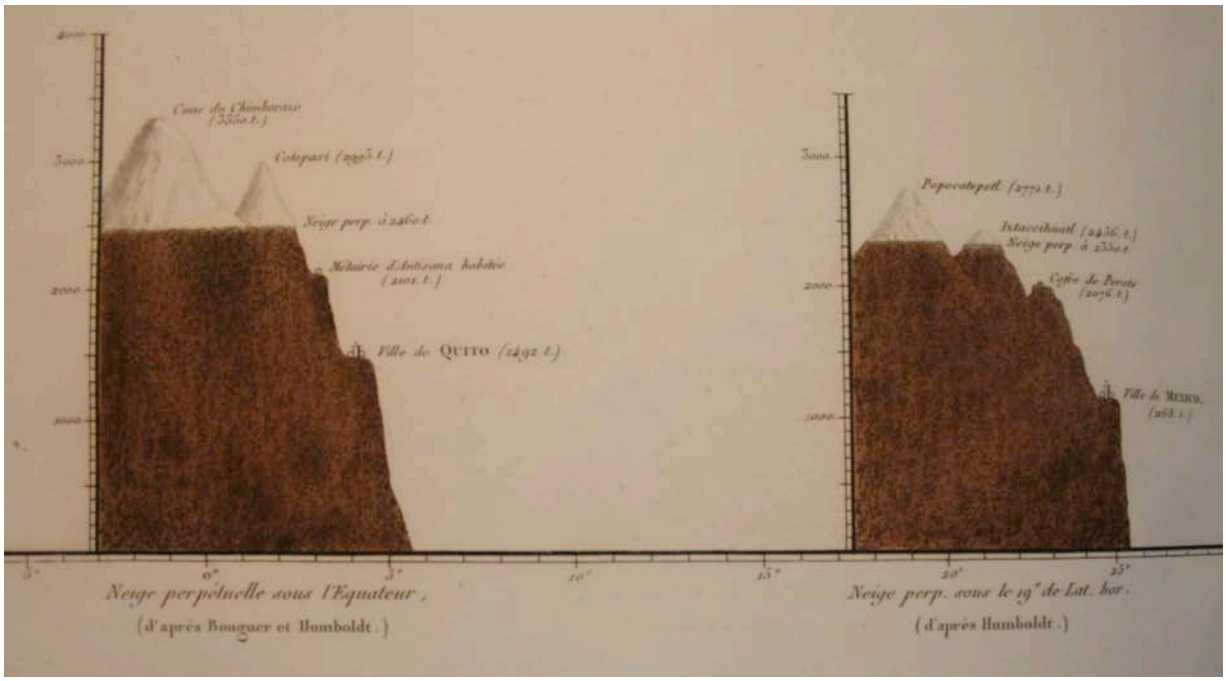


Illustration 4: Lower limit of perpetual snows at different latitudes

Source: Atlas géographique et physique du nouveau continent, 1814, Paris, Schoell

Though he had noted that the elevation of mountains was modest in comparison to their horizontal extension, Humboldt nonetheless was struck by the implications of their verticality. He was less curious about the gravitational effects of the slopes (landslides, streams, plant migrations upward and downward, etc.) than he was about the relation between height and climate. He was fascinated by the existence of "*eternal snow*" or "*perpetual snow*" (ill. 4) at the highest altitudes, and he often used metaphors for describing how mountain ranges link the level of the sea to the highest layers of the atmosphere. Mountains are compared to "*reefs or shoals [hauts-fonds] of the aerial ocean*," (Humboldt, 1843, III, p 209) while their "*bases rest on the bottom of the ocean*" (Humboldt, 1877 (1845), I, p 287). In delineating the field of plant geography, much broader than the study of plant

distribution along mountain slopes, he continued to point to the vertical differentiation of vegetation:

> *"This scientific field considers vegetation in the context of its local associations in different climates. Vast as its own object, it paints in broad strokes the immense expanses of territory which are occupied by plants, from regions of perpetual snow to the depths of the ocean, and even into dark caves of the earth's interior where cryptogams, as little known as the insects which feed on them, grow" (Humboldt, 2012 (1805)).*

Humboldt was especially eager to explain this vertical diversity of vegetation in terms of gradients in atmospheric pressure and temperature. This characterization and corresponding explanation of plant distribution in terms of physical criteria had already been made by naturalists for decades when Humboldt entered this field. He recognized the work of many of his predecessors, from Bembo for the measurements he took in the 16$^{th}$ century on the slopes of Etna, to Tournefort, Candolle, Ramond de Carbonnières, Wildenow, or Forster. However, if Humboldt was grateful to those who provided him with ideas and observations, regarding mountain vegetation as well as in many other domains of knowledge, he also innovated in this field in several ways.

First, faithful to his project to connect diverse phenomena in a comprehensive understanding of nature, he didn't focus exclusively on the correlation between altitude and vegetation types. As often as possible, he strove to explain the distribution of plants in mountain regions according to a broad set of factors: temperature, humidity, quality of solar radiation, nature of the soil, etc. It is for this comprehensive approach that Humboldt is often seen as a founding father of ecology.

Moreover, Humboldt always sought to compare any local observation to others made elsewhere on the globe. In his Essay on the Geography of Plants, when listing, in an illustrated way, a series of questions which lie at the very core of this new field of knowledge, he asks: "*What formal analogies could link the alpine vegetation of the Andes with those of the higher reaches of the Pyrenees?*" (Humboldt, 2012 (1805)). In the same essay, he invites scientists to undertake broader comparisons, such as "*to compare equinoctial (tropical) vegetation with that of Europe*". A similar attention leads him to compare altitudes of the limit of "*perpetual snow*" on various slopes and to illustrate this accordingly.

His personal fieldwork, which led him to the top of many summits around the world, gave great importance to factual observations and analytic correlations of mountain features. His travel across the Atlantic Ocean brought him first to the Canary Islands, where in June, 1799, he ascended the Pico de Tenerife (3718m). When visiting the Northern Andes, he climbed Puracé (4910m), Pichincha (4776m), Antisana (5 753 m), and Cotopaxi (5911m). His most famous ascent, in June 1802, led him and two partners close to the summit of Chimborazo (6310m), most likely to the highest altitude ever reached by man on earth. Humboldt never displayed excessive pride about these ascents, at least in his writings, instead focusing on their scientific interest, which he maintained was limited. Commenting on his account of the ascent of the Pico de Tenerife, Humboldt wrote: "*it appears to me that, in a narrative, the principal end of which is the progress of physical knowledge, every other consideration ought to be subservient to those of instruction and utility*" (Humboldt, 1877 (1814), I, p 233). For Chimborazo, he waited 35 years before publishing an account of his ascent, and even then he insisted that nothing merited great attention, neither the climb itself, nor the

scientific output:

> *"Chimborazo became the continuous object of questions addressed to me after my first return to Europe … I will extract from the yet-unpublished parts of my diaries the very simple account of a mountain excursion … which cannot offer anything but some dramatic interest…" (Humboldt, 1838, p 7-8).*

Elsewhere, even more explicitly, he asserted that :

> *"to reach great heights has little interest for science when they are well above the limit of snow and can be visited for but short periods of time" (Humboldt, 1838, p 6).*

However, these ascents gave him the opportunity to analyze various phenomena, which change along his way, such as the nature of rocks, plants and animals. The many comments made from his ascent of Chimborazo show him observing the presence of plants and animals at a very high altitude and comparing these with records made on other mountain peaks:

> *"On the Chimborazo, eight thousand feet higher than Etna, we found butterflies and other winged insects, borne by ascending currents of air to those almost unapproachable solitudes, which man, led by a restless curiosity or unappeasable thirst of knowledge, treads with adventurous but cautious steps: like him strangers in those elevated regions, their presence shows us that the more flexible organization of animal creation can subsist far beyond the limits at which vegetation ceases. The condor, the giant of the Vulture tribe, often soared over our heads above all the summits of the Andes, at an altitude higher than would be the Peak of Teneriffe if piled on the snow-covered crests of the Pyrenees" (Humboldt, 1850 (1849), p 227).*

In the same narrative, he gathers observations related to animals, rocks and snow:

> *"On the eastern declivity of the Chimborazo, the height of 18,096 feet—a height at which the barometer sank to 13 inches 11 1/5 lines, we saw winged insects fluttering around us. We could see that they were Dipteras, resembling flies, but on a sharp ridge of rock (cuchilla) often only ten inches wide, between steeply descending masses of snow, it was impossible to catch the insects. The height at which we saw them was nearly the same at which the uncovered trachytic rock, piercing through the eternal snows, gave to our view, in Lecidea geographica, the last traces of vegetation. The insects were flying at a height of about 2850 toises higher than Mont Blanc" (Humboldt, 1850 (1849), p 248).*

He was also curious about physiological effects of altitude on his own body and on those of his companions, and compared these to reports in existing literature:

> *"We all begin to suffer, more and more, from nausea. The urge to vomit was joined by vertigo, and was much more disturbing than the difficulty breathing (…) Our gums and lips bled, and even the conjunctival membrane (...) for all of us, was filled with blood. These manifestations of blood in our eyes, and bleeding from the gums and lips, did not worry us at all, as we knew about them from a great number of previous examples. In Europe, Mr. Zumstein showed blood at a much lesser height on Mont-Rosa (…) All these phenomena vary greatly, according to age, constitution, skin sensitivity and accumulated muscular fatigue due to previous physical exertion; but for each individual they are a kind of measure of the*

> *rarefaction of the air and the absolute altitude reached. According to my observations in the Andes they occur, in white men, when the barometer rests between 14 inches and 15 inches 10 lines. We know that ordinarily the heights to which aeronauts claim to have risen deserve little faith, and if Mr. Gay-Lussac, a sure and extremely exact observer, did not show blood on September 16, 1804 at the prodigious height of 21,600 feet, and therefore between Chimborazo and Illimani, it should perhaps be attributed a total absence of muscular movement" (Humboldt, 1838, p 23)*

As when he was a student, testing the reaction of his body to the stimuli of electricity (Humboldt, 1799)[17], Humboldt put his body under the stress of altitude, turning it into a field for experimentation.

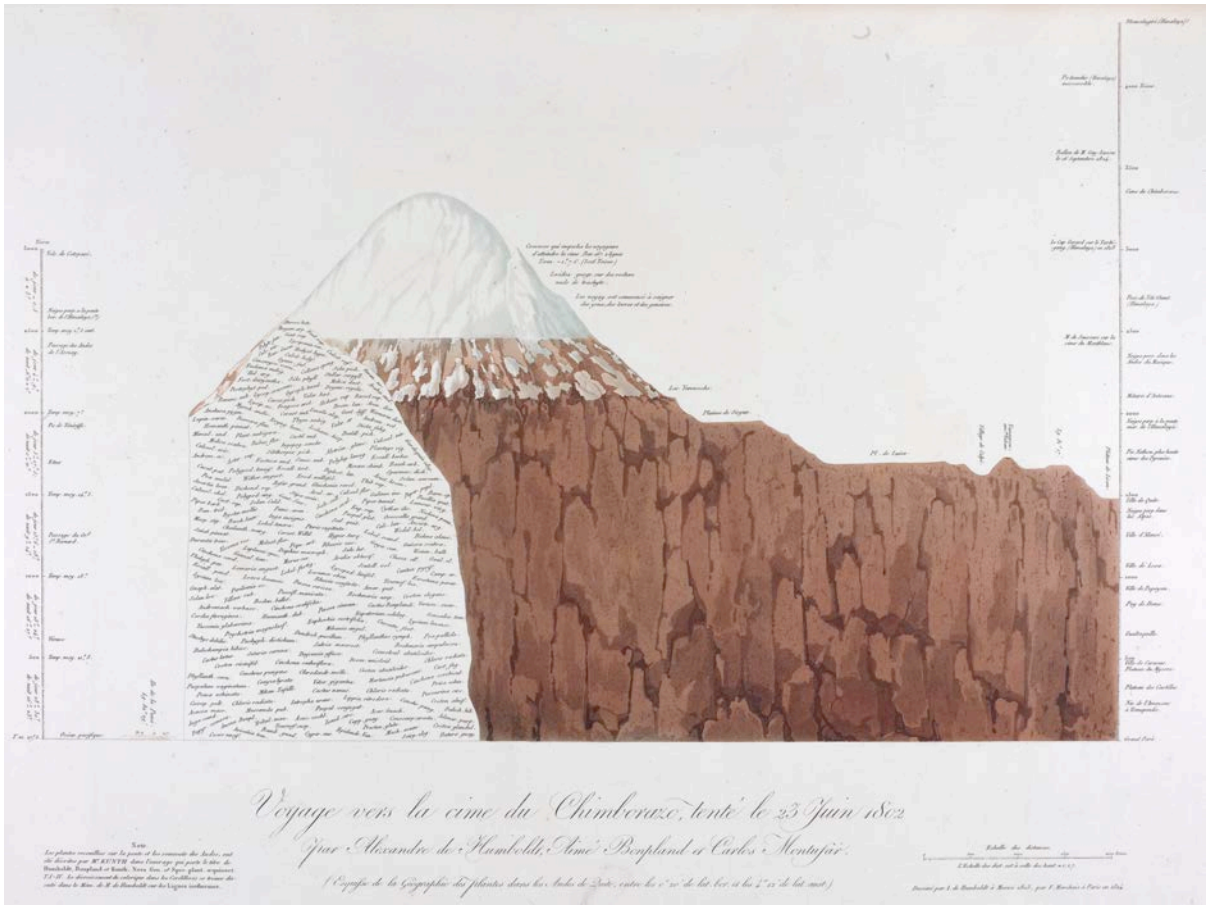


Illustration 5: Journey toward the summit of Chimorazo attempted June 23, 1802 by Alexander Humboldt, Aimé Bonpland and Carlos Montufar

Source: Atlas Géographique et Physique du Nouveau Continent, 1814, Paris, F. Schoell

Another feature of Humboldt's observational methods lies in his complex ensemble of measurement protocols. We saw, above, that the systematic measuring of altitude allowed him to estimate the volume of mountain ranges. But, more importantly, it also allowed him

[17] For a detailed analysis, see Trumpler, 1992

to correlate altitudinal gradients with other variations. For this, he made use of various instruments, the operation of which he had learned in his youth. We know that he took a course on barometric measurement in Jena in 1794[18]. Before he left for South America, and aided by an inheritance from his mother two years earlier, Humboldt bought many devices - sextants, theodolites, barometers, thermometers, chronometers, quadrants, compasses, eudiometers, electrometers, hygrometers, etc. – and he carried these throughout his journey. When he stopped along a mountain slope or at its summit, he took dozens of measurements: air pressure (in order to check the law of Laplace and the temperature gradient of Ramond), the chemical analysis of the air, the intensity of the color of the sky, the temperature of lava when he got close to a crater and, last but not least, altitude, taken by barometer when on a summit and by trigonometry when at a distance. With these varied measures, and with altitude as a reference, Humboldt could correlate diverse phenomena with specific attention to the vertical distribution of plants and the "*limit of perpetual snow*".

Finally, Humboldt sought to relate observations of vertical distribution of phenomena with what he knew about the distribution of the same phenomena across latitude, from the poles to the Equator. Here is the very core of his comparative methodology, especially for vegetation: "*Plant geography sorts out vegetation in terms of (…) altitude and climatic zones where they occur*" (Humboldt, 2012 (1805)). Building on the intuition of early naturalists such as Tournefort, he concluded that the diminishing of average temperature along a slope and its consequences on plant distribution is similar to the diminishing of temperature along a meridian, with similar consequences. Conceived this way, mountain ecology is not a specialty by itself; conducting physical measurements and ecologic observations in mountain regions is instead a specific moment and opportunity toward a broader conception of comparative and global ecology. This juxtaposition of zonal distribution and altitudinal distribution of plants appears as a leitmotif[19] in Humboldt's publications, giving mountain slopes a major role in his scientific method.

## 7. Dwellings : the role of mountains in the making of human diversity

Humboldt was especially curious about landforms, climates, and plant and animal distributions, but he was also attentive to human beings. He was somewhat cautious, however, when writing about them and their relation to the natural environment. He knew how human mobility could be hard to explain, and he appreciated how human beings can transform their environment. However his deep interest in human cultures and his desire to build an encompassing geographical knowledge led him to speculate on a few aspects of the relationship between people and the natural features of their surroundings.

Humboldt believed in the unity of the human species but also its progressive differentiation, owing, in part, to natural features at both the continental and local level:

> *"As the 'external' configuration of continents, which we have already described in their horizontal expansion, exercises, by their variously indented littoral outlines, a favorable influence on climate, trade, and the progress of civilization, so likewise*

[18] According to Ch. Minguet, 1969.

[19] Though fairly short, the *Essay on the Geography of Plants* contains several phrases which combine references to zonation and altitude, rhetorically designating, in a metonymic way, the universality of the phenomena he describes and the knowledge he provides: "for all regions and at all altitudes," "in all climates and at all elevations," "all zones and all elevations above sea-level," etc.

> *does their internal articulation, or the vertical elevation of the soil (chains of mountains and elevated plateaus), give rise to equally important results. Whatever produces a polymorphic diversity of forms on the surface of our planetary habitation - such as mountains, lakes, grassy savannas, or even deserts encircled by a band of forests -- impresses some peculiar character on the social condition of the inhabitants. Ridges of high land covered by snow impede intercourse; but a blending of low, discontinued mountain chains and tracts of valleys, as we see so happily presented in the west and south of Europe, tends to the multiplication of meteorological processes and the products of vegetation, and, from the variety manifested in different kinds of cultivation in each district, even under the same degree of latitude, gives rise to wants that stimulate the activity of the inhabitants" (Humboldt, 1877 (1845), I, p 299)*

Placing humankind within the frame of his analysis of relations between phenomena, Humboldt remained faithful to his characteristically naturalist way of thinking. However, he always maintained a balance between statements which sound very deterministic, common at his time, and more nuanced positions which kept him away from excessive generalizations. A discussion on human diversity, the "*discord of nations*", and the influence of climate on civilization, published in Aspects of Nature, displays such an uncertainty:

> *"the knowledge of the character which nature assumes in different regions is moreover intimately connected with the history of man, and of his civilization. For although the commencement of this civilization is not solely determined by physical relations, yet the direction which it takes, the national character, and the more grave or gay dispositions of men, are dependent in a very high degree on climatic influences. How powerfully have the skies of Greece acted on its inhabitants (…) The poetry of the Greeks, and the ruder songs of the primitive northern nations, owe great part of their peculiar character to the aspect of the plants and animals seen by the bard, to the mountains and valleys which surrounded him, and to the air which he breathed" (Humboldt, 1850 (1849), p 235).*

Not surprisingly, this way of thinking and its internal nuances found expression in Humboldt's approach to mountains. Thus at a time when it became common to imagine that East Asian tribes entered the American continent from its North-West, he imagined that those people, who became Amerindians, "*enjoying cold climates (…) headed southward following the high mountains of the Andes (…) people from the North, when migrating toward the Equator, could only be pleased in such a climate*" (Humboldt, 1850 (1849), II)[20]. This theory allowed him to suggest that the existence of such a "*great civilization on the high plateaus (of the Andes*)" is related to the mild climate of the region, similar to the one of Japan. When talking about human beings and "nations", Humboldt again turned to the correlation of altitudinal and latitudinal distribution of phenomena – the essential point in his geography of plants.

However, Humboldt never oversimplified his analysis. When speaking of major mountain ranges, the Andes for example, he never attributed a radical specificity to "mountain peoples" or "*mountaineers*" (montagnards). The term is infrequent in his writings, much

[20] The first part of the quotation is present in all English editions of the book. The second part comes from an addendum of the 3rd edition in French, 1851, p 191.

rarer than in most scientific and philosophical literature of his time. When present, it is mainly used for locating a group of people, sometimes to describe how these people become accustomed to their mountain environment, never to determine their characters from mountain nature. In a book devoted to indigenous people of America, he mentions the "*fear of mountain-dwellers in the tropics to expose themselves to the heat of the plains*." (Humboldt, 1814 (1810), I, p 17). But contrary to many authors of his time, to whom he has been compared[21], he does not go much further, avoiding inferences from this naturalist perspective regarding a human or racial type for the inhabitants of mountain regions. In his Political Essay on the Kingdom of New Spain, for example, he distances himself from simplistic statements made by some prominent naturalists of the 18th century on the skin color of Black people living in African mountains. Contrary to Buffon and many other scientists of that time (see Debarbieux, 2008a), Humboldt didn't believe that Black inhabitants of the mountains and high plateaus differed radically from their counterparts of the plains:

> *"The negros of the mountains of Upper Guinea are not less black than those who live on the coast (…) The Indians in the torrid zone who inhabit the most elevated plains of the Cordillera of the Andes, and those who under the 45° of south latitude live by fishing among the islands of the archipelago of Chonos, have as coppery a complexion as those who under a burning climate cultivate bananas in the narrowest and deepest valleys of the equinoxial region (…) All these facts tend to prove that notwithstanding the variety of climates and elevations inhabited by the different races of men, nature never deviates from the model of which she made selection thousands of years ago" (Humboldt, 1811, I, p 144-45).*

Similarly, he eschews any speculation on the moral character and collective virtues of "*mountain people*" or "*mountain-dwellers*." He never described them as being either (noble) savage, or backward peoples, unable to emancipate themselves from their natural condition. This mythology, so popular at the time, could not fit his positive conception of progress and the historical transformation of societies, nor the importance he gave to the ability of human beings to act consciously, according to their capacity for reflexivity[22].

## 8. Landscape: mountain as an emblematic form of unified knowledge

The last figure of mountains we can point to in Humboldt's work refers to his conception of landscape. As has been shown by various scholars (such as Godleweska, 1999; Briffaud, 2006; Farinelli, 1999; Mitchell, 1994), this concept is probably the most integrative in Humboldt's prose, where depictions of landscapes allowed him to articulate, through a visual experience, the wide range of phenomena he wished to interrelate, including human sensibility and imagination. Mountain landscapes, above all, provided the vehicle for this approach.

### *Landscape as a visible expression of natural arrangements*

Humboldt was not particularly interested in mountain landscapes as they appear to the traveler, or to the settled inhabitant of deep valleys at a local scale. When using landscape as a way to depict natural phenomena, he did not resort to the picturesque, sublime or the

[21] See as an example Minguet, 1969.
[22] See for example what he writes in *Cosmos*, 1877 (1845), vol I, p 358

close-up compositions which were popular at the time. His writings and drawings focus more on landscapes seen at a distance, displaying a wide array of rock formations, vegetation levels, and climatic contrasts. In this regard, equatorial mountains were the most interesting:

> *"This portion of the surface of the globe affords in the smallest space the greatest possible variety of impressions from the contemplation of nature. Among the colossal mountains of Cundinamarea, of Quito, and of Peru, furrowed by deep ravines, man is enabled to contemplate alike all the families of plants, and all the stars of the firmament (…) There the depths of the earth and the vaults of heaven display all the richness of their forms and the variety of their phenomena. There the different climates are ranged the one above the other, stage by stage, like the vegetable zones, whose succession they limit; and there the observer may readily trace the laws that regulate the diminution of heat, as they stand indelibly inscribed on the rocky walls and abrupt declivities of the Cordilleras" (Humboldt, 1877 (1845), I, p 46).*

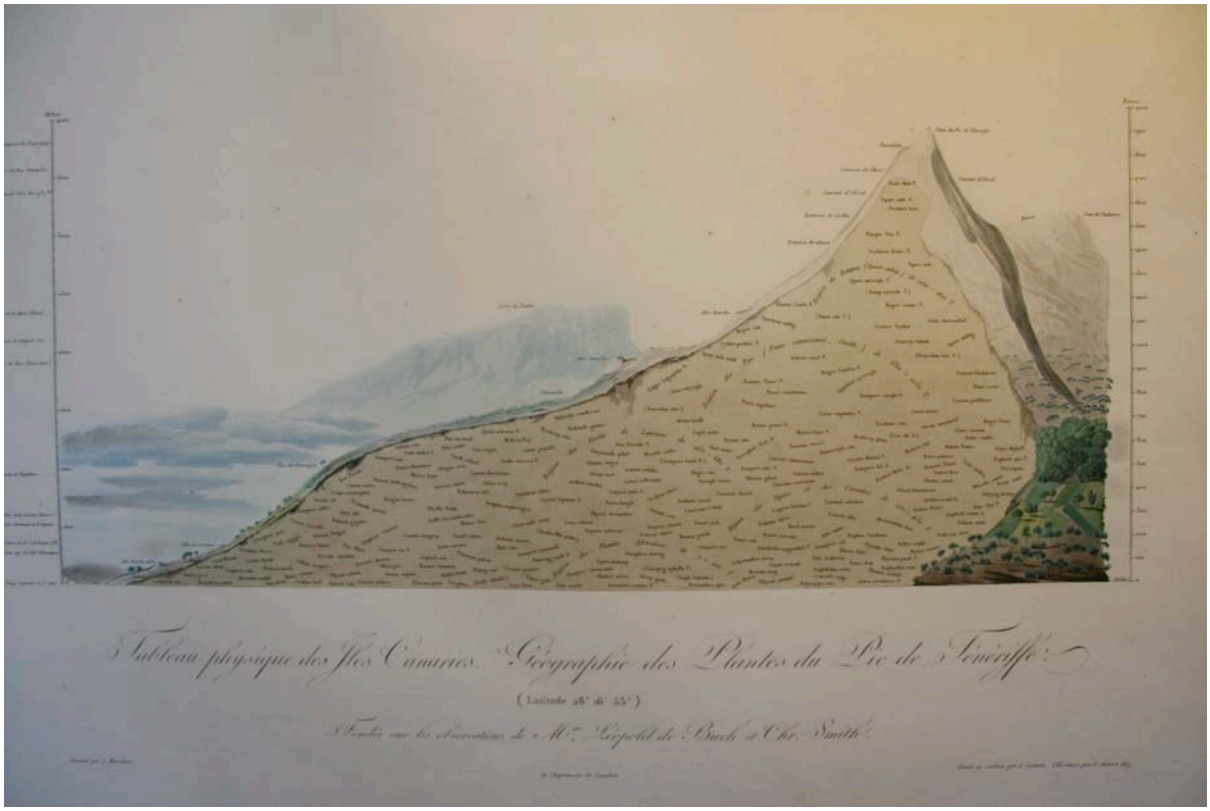


Illustration 6: Physical tableau of the Canary Islands – Geography of the plants of the Tenerife Peak (and detail),

Source: Atlas Géographique et Physique du Nouveau Continent, 1814, Paris, Schoell

His drawings, and the paintings he ordered for illustrating his books, depict many landscapes of this kind, most of them emphasizing, in a somewhat exaggerated manner, the discontinuities that for him were most significant, for example the line of "perpetual snow"

to which he gave so much importance in his writings and measurements. These drawings and paintings were intended to have pedagogic value: they are supposed to impress the reader and, at the same time, to offer distinct information on the altitudinal distribution of natural phenomena. This is why so many of them include names of plants and animals, allowing the reader to correlate these with the altitude of their location (ill. 6). He happens to be very explicit regarding this intention: "*people want to see, and I show them a microcosm on a sheet of paper* " (Quoted in Drouin, 2003, p 60).

***Landscape between scientific knowledge and sensible experience***

Though widely recognized and commented, Humboldt's interest in landscape painting goes beyond its pure conceptual and pedagogic value. Mountain landscapes are a major tool for articulating naturalist knowledge, on one side, and sensory experience, imagination and artistic creation, on the other.

His attempt to bridge the gap between these worlds is rooted in his exposure to German Romanticism when he was a young man. Throughout his life, he promoted forms of knowledge which could combine reason and imagination:

> *"It would be a denial of the dignity of human nature and the relative importance of the faculties with which we are endowed, were we to condemn at one time austere reason engaged in investigating causes and their natural connections, and at another that exercise of the imagination which prompts and excites discoveries by its creative powers" (Humboldt, 1877 (1845), I, p 78).*

Evidence of this intention recurs in his writings. In several sections of his Personal Narrative and in many of his letters, he refers to this ambition or adopts a specific style, less eager to describe things as they can be analyzed, more able to give account of informal modes of perception:

> *"In the forests of the Amazon, as on the slopes of the Andes, I felt that the surface of the Earth was alive everywhere with the same spirit, the very life which is found in the rocks, the plants and the animals, as in the heart of humanity from one pole to the other. Everywhere I went I realized just how much the relationships I formed in Jena (where I conducted part of my academic training) had a profound influence on me, and how much, inspired by Goethe's perspectives on Nature, I had gained new organs of perception" (Humboldt, 1904, p 211-2).*

Accordingly, he criticizes Buffon, " *great and earnest as he was" as a natural scientist, for having failed to "seize upon the imagination by presenting a visible picture of actual nature, or conveying to the senses the echo, as it were, of reality*" (Humboldt, 1877 (1845), II, p 75).

The experience of mountain landscapes is especially conducive to such a sensibility:

> *"On the shore of the South Sea[23], when the long winter rains are over, when the transparency of the air has suddenly increased, Chimborazo appears, like a cloud on the horizon; It isolates itself from the neighboring peaks; it rises above the whole Andes cordillera, like that majestic dome, Michelangelo's brilliant work, rising above the ancient monuments encircling the capitol" (Humboldt, 1869, p76).*

[23] Humboldt's use here of "South sea" refers to the Pacific Ocean.

Describing Cayambé, one of the highest volcanoes of the Quito region, he combines subjective and objective elements:

> *"Among the mountains covered with eternal snow, that surround this city of Quito, Cayambe, which is the most beautiful as well as the most majestic, never ceases to excite admiration at sunset, when the volcano of Guagua-Pichincha, situate to the west, or toward the Pacific Ocean, throws its shadow over the vast plan, which forms the foreground of the landscape. (…) We may consider this colossal mountain as one of those eternal monuments, by which nature has marked the great divisions of the terrestrial Globe" (Humboldt, 1814 (1810) II, p 100).*

He even suggests that the presence of a mighty landscape nearby stimulated his own intellectual activity. Introducing the Essay on the Geography of Plants, he writes: "*it was there, in full view of these marvelous phenomena which I wanted to describe, at the foot of Chimborazo, on the South Pacific shores, that I wrote most of this text*" (Humboldt, 2012 (1805**)**).

However, Humboldt never pretended to be an artist himself. His own drawings are guided by scientific and didactic objectives, not artistic ones. In a book mainly comprising graphic representations of Andean volcanoes, he explained the nature of the pictures: "*the scientific demands of a geologist should naturally differ from the artistic emotion that can bring out the picturesque arrangement of a landscape*." (Humboldt, 1854, p 6). Because Humboldt had such a clear notion of the different competencies of scientists and artists, he encouraged the latter to paint landscapes, especially tropical landscapes. A famous section of Cosmos is dedicated to this.[24] He wrote a similar invitation in his Essay on the Geography of Plants: "*It would indeed be an enterprise worthy of a distinguished artist to study the physiognomy of these groups of plants which I have listed, not in the greenhouse or botanical text books, but in nature itself.*" (Humboldt, 2012 (1805)). For Humboldt, mountain landscapes, when experienced at a distance, are the perfect object for both the scientist and the artist, the two giving different points of view of the same reality, the artist an aesthetic account, the scientist, a more analytic perspective.

***A natural history of imagination***

In emphasizing the importance of sensibility for experiencing nature and landscape, Humboldt outlined a natural history of imagination. In an introductory section of Cosmos, for example, Humboldt wrote that he wanted

> *"to remind the reader how differently the aspect of nature has acted on the intellect and feelings of different nations at different epochs (…) In order to depict nature in its exalted sublimity, we must not dwell exclusively on its external manifestations, but we must trace its image, reflected in the mind of man, at one time filling the dreamy land of physical myths with forms of grace and beauty, and at another developing the noble germ of artistic creations" (Humboldt, 1877*

[24] "He who, with a keen appreciation of the beauties of nature manifested in mountains, rivers, and forest glades, has himself traveled over the torrid zone, and seen the luxuriance and diversity of vegetation, not only on the cultivated sea-coasts, but on the declivities of the snow-crowned Andes, the Himalaya, or the Nilgherry Mountains of Mysore, or in the primitive forests, amid the net-work of rivers lying between the Orinoco and the Amazon, can alone feel what an inexhaustible treasure remains still unopened by the landscape painter between the tropics in both continents, or in the island-world of Sumatra, Borneo, and the Philippines" (Humboldt, 1877 (1845), vol 2, p93).

*(1845), II, p 20).*

His Essay on the Geography of Plants already outlined such a project when he promoted the study of "*the influence which vegetation can have on the tastes and imaginations of people*" (Humboldt, 2012 (1805)). Once again, he promotes comparative methodologies, here for understanding the differences between people who are not exposed to the same kind of landscapes. Andean people are said to have developed a specific sensibility from their daily experience of the rich nature there are nested in. Mexican and African peasants are said to be even more sensitive to their respective mountainous environments. Comparatively Europeans, whose environment is said to be less stimulating, have developed to the highest degree the "*arts of imitation*" through arts and sciences, especially for mountain landscapes:

> *"European people do not enjoy a similar advantage (than Andean people) (…) But the richness and perfection of their languages, the imagination and sensitivity of their poets and painters, compensate somewhat. It is through imitative art that we can retrace the varied picture of tropical lands." (Humboldt, 2012, p xx)*

The comparative analysis of the imagination of people concerning their natural environment, therefore, was part of Humboldt's project of building an all-encompassing natural history, and he referred often to mountain landscapes as illustrations of the diverse attitudes toward nature shown by the various people of the Earth.

**Conclusion**

In his numerous books, papers and letters, Humboldt constantly refers to mountains as major elements of the natural phenomena he studied. But he referred to them in very diverse ways, and he assigned them varied roles and scientific meanings: topographical forms, climatic zones, geologic features, causes of ecological fragmentation, places of daily living for human communities, types of landscape, sources of imagination, motifs of landscape painting, etc. He thus covered most of the scientific conceptions of mountains that scientists from the 18$^{th}$ century to the middle of the 20$^{th}$ century employed in their discussions about them. Such a broad view on mountains found few equivalents in the academic literature of this period. Nonetheless, Humboldt cannot be regarded as a "mountain scientist" since he was never willing to delineate such a field or specialty.

Putting aside any psychological reasons, which I have chosen not to analyze here, the importance Humboldt ascribed to mountains can be explained in two different and complementary ways:

First, mountains provide an especially diverse and wide range of places for observations and measurement, always different, yet always potentially comparable on basic criteria such as altitude and latitude. Mountains regions provided comparable settings useful to his project of building a global knowledge on the "*physics of the Earth*", taking into account that he could not imagine any kind of global knowledge which was not based on empirical observations at local scales. This match of mountainous contexts to his methodological requirements made them excellent laboratories for natural science.

Second, mountains are perfect objects for building and displaying the whole philosophy of his project. Being present at all stages in the development of his analytical style, they provide the ontological and rhetorical thread that helped him sustain his conception of the interconnection of natural phenomena. It is with the help of mountains that Humboldt

pursued his will to connect the internal, external and aerial layers of the Earth, to articulate topographical, climatic and vegetal features of the surface of the Earth, and to analyze the interaction between the natural features of landscape and the imaginations of people, including scientists and artists. For Humboldt, mountains are the living expression of this fundamental interplay among natural and human phenomena.

For these methodological, ontological and rhetorical reasons, Humboldt became the scientist of the 19th century who, more than any other, was willing to show that knowledge of mountains goes hand in hand with knowledge of the world. His holistic vision found in the peaks of the earth its best illustration.

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