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REVIEW ARTICLE

GEOETHICS AS AN EMERGING DISCIPLINE: PERSPECTIVES, ETHICAL CHALLENGES AND PROSPECTS

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ABSTRACT

Geoethics is the union of the prefix "geo" and the word "ethics". This means responsibility towards the Earth, an ethics for the planet. Geoethics involves research and reflection on the values which underpin appropriate behaviours and practices, wherever human activities interact with the Earth system. Geoethics deals with the ethical, social and cultural implications of geoscience knowledge, education, research, practice and communication, and with the social role and responsibility of geoscientists in conducting their activities. Geoethics recognizes that human beings are a geological force capable of acting on natural environments, and in virtue of this prerogative assigns to them an ethical responsibility towards the Earth system. Studying and managing the Earth system, exploiting its geo-resources, intervening in natural processes are actions that involve great responsibilities towards society and the environment are the exclusive reserve of geoscientists. Only by increasing the awareness of this responsibility, can we work with wisdom and foresight, and respect the balances that exist in nature while guaranteeing a sustainable development for future generations. Promoting Geoethics articulates the responsibilities of geoscientists to improve both the quality of professional work and the credibility of geoscientists, to foster excellence in geosciences, to assure sustainable benefits for communities, as well as to protect local and global environments; all with the aim of creating and maintaining the conditions for the healthy and prosperous development of future generations. Equally as important to the success of the scientific enterprise are the personal attributes required of being a scientist and the responsible conduct of scientists in their personal interactions with colleagues and the public. The paper therefore provides an overview the scope and dynamics of the emerging field of geoethics, by showing the trajectory that has led to the current point of development of geoethics, challenges, prospects and suggesting some cues for thought for further advancements of ethical thinking in geosciences.

KEYWORDS

Geoethics, ethical challenges, professionalism, ethical requirements, integrity, professional standards

1. INTRODUCTION

The professional duties of geoscientists go beyond scientific and technological knowledge and skills, due to the fact that ethics must be an important part of the professional responsibility of geologists [1]. Ethics is part of our professional responsibility. Without attempting to be exhaustive, ethics is defined as: (i) "the philosophical study of the moral value of human conduct, and of the rules or principles that ought to govern it"; (ii) "a code of behavior considered correct, especially that of a particular group, profession, or individual" and (iii) "the moral fitness of a decision, course of action, etc" (Collins English Dictionary). Geoethics is a form of applied ethics, a new branch of ethics dealing with moral problems, practices and policies especially connected to geosciences, the need for which was first addressed on geological and geoscience conferences in the last two decades [2]. Generally, Ethics is the field of knowledge that deals with the principles that govern how people behave and conduct activities. Professional ethics on the other hand, refers to "those principles that are intended to define the rights and responsibilities of scientists in their relationship with each other and with other parties including employers, research subjects, clients, students, etc.", [3].

Ethics is well established as being of relevance to other scientific disciplines (e.g., medical ethics, bioethics). Given the multiple interfaces of geoscience with society, it is appropriate that the social role and responsibilities are considered – geoethics. This is not just a niche area of research but extends to all geoscientists irrespective of their field (e.g., volcanology, engineering geology, hydrogeology, metamorphic petrology) and employment sector (e.g., industry, academia, public sector). Geoethics is particularly concerned with the way humans relate to the geosphere [4]. At the same time, Geoethics focuses on how geologists develop their academic and professional work which impacts in sustainability [5]. Therefore, geoethics is a subject that discusses principles which guide scientists on how to deal with the non-living part of the planet.

Geoethics was born in 1991 at the junction of *Ethics* and *geology* despite the term being later used with various meanings which are not directly related to Geology and Geosciences [6-11]. Broadly, it derives from 1996, when a group of geographers from North America and the UK envisioned exploring more thoroughly the relationship of geography and moral philosophy (Proctor, 1996), and a specific listserv named "Geo-Ethics" was made on geography, ethics and justice [12].

Geoethics was born to define a conceptual substratum of categories, useful

as framework of reference for geoscientists, to help them develop a new way of thinking and interacting with the Earth system [13]. Geoethics provides a framework for reflecting on the shared values that underpin the work of geoscientists, and how these values shape the professional actions, and interactions with colleagues, society and the natural environment.

The International Association for Promoting Geoethics and the 'Cape Town Statement on Geoethics **(CTSG)**' defines geoethics as:

"Research and reflection on the values which underpin appropriate behaviours and practices, wherever human activities interact with the Earth system. Geoethics deals with the ethical, social and cultural implications of geoscience knowledge, education, research, practice and communication, and with the social role and responsibility of geoscientists in conducting their activities."

The "Cape Town Statement" statements provide clear references to the eminent position of geoethics as an under-pinning principle for geoscientists and geo-scientific information and knowledge to follow while addressing societal challenges and the SDGs. Geoscientists have specific knowledge and skills, which are required to investigate, manage and intervene in various components of the Earth system to support human life and well-being, to defend people against geohazards and to ensure natural resources are managed and used sustainably. As such, geological services include geoethics values as they are aimed at safeguarding the exploration and safe development of natural resources and subsurface capacities based on impartial and scientifically validated information and knowledge, always having the interests of society as a core value. This entails serious ethical obligations. Therefore, geoscientists must embrace ethical values in order to serve the public good.

The fundamental values of geoethics, involves the following:

(1) Ensuring sustainability of economic and social activities in order to assure future gen-erations' supply of energy and other natural resources.

(2) Sharing knowledge at all levels as a valuable activity, which implies communicating science and results, while taking into account intrinsic limitations such as probabilities and uncertainties.

(3) Verifying the sources of information and data, and applying objective, unbiased peer-review processes to technical and scientific publications.

Geosciences have major impacts on the functioning and knowledge-base of modern societies. Humans are recognized as a "geological force", capable of modifying natural environments, and in virtue of this prerogative they have an ethical responsibility towards the planet. By studying and managing the Earth system, exploiting its geo-resources, intervening in natural processes are actions that involve great responsibilities towards society and the environment, of which perhaps geoscientists, are not sufficiently aware. Only by increasing the awareness of this responsibility, can geoscientists work with wisdom and foresight, and respect the balances that exist in nature while guaranteeing a sustainable development for future generations.

Geoethics as an emerging subject promotes a way of thinking and practicing geosciences, within the wider context of the roles of geoscientists interacting with colleagues, society and the planet. Only by guaranteeing the intellectual freedom of researchers and practitioners to explore and discover in the Earth system, is it possible for geoscientists to follow ethical approaches in their work. Likewise, only by increasing re-searchers' and practitioners' awareness of the ethical implications of their work is it possible to develop excellent geoscience to serve society and to reduce the human impact on the environment. This paper, therefore, summarizes the fundamentals of geoethics, highlights its institutionalization and current development and emphasizes the significance of geoethics, providing primary information about its innovation and progress as well as the current and future developments in geosciences.

2. GEOETHICS: HISTORICAL OVERVIEW

The word "geoethics," as used starting from the early 1990's, signifies the duty of mankind to behave responsibly and become the natural consciousness of the planet [14,15]. Geoethics was born in 1991, and it was established as an independent scientific field in 1992, in the context of the symposium "The Mining Pøíbram in science and technique". Dr. Vaclav Nemec (since 2004 Vice-president for Europe of the Association of Geoscientists for International Development - AGID, Head of the AGID Working Group for Geoethics) is considered the father of this discipline. As Nemec stated "he was inspired by the field of business ethics, where his wife, Lidmila Nemcova, had been engaged, as represented by the prestigious French Professor Jean Moussé", to start to investigate problems of ethics applied to the Earth sciences [16].

Geoethics recognizes the contingency of human evolution on the planet. A researcher identifies *Homo sapiens* as geological force acting on the geological and biological environments and assigns to humans an ethical responsibility that arises from the consciousness of being a modifier of Earth systems [17]. There had been attempts to date formulation of Geoethics in 1973, when Antonio Stoppani, Italian geologist and palaeontologist proposed an idea of introducing the anthropologic era into the geochronological scale - an era of domination of Homo sapiens that significantly affected to the natural environment. In 1980's, this idea was captured by Eugene Stoermer, American ecologist, and in 2000, it was popularised by Paul Crutzen, Nobel Prize winner for chemistry as a proposal of the Commission for Stratigraphy of the Geological Survey of London to use the term "anthropocene" that indicates the geological epoch with the level of human activity that plays a significant role in the Earth ecosystem [18]. The advanced statements did not mean formulation of Geoethics in the rank of a scientific discipline. This was more occurrence of ecological way of thinking. While formulation of ecological ethics was based on awareness of significance of the impact of human activity to natural systems and crust of the planet, together with this awareness, Geoethics was originated by the following assumptions:

(1) accumulation of geological knowledge that has facilitated understanding of geographic irregularity of distribution of mineral deposits, their limitation in volume/size, exhaustibility, non-renewability, potential for high economic, environmental and social risks that are associated with mining;

(2) occurrence of ethical problems like fair distribution of income from mining of minerals, the minerals belonging not to contemporary, but also future generations, responsible (irresponsible) subsoil use, acceptability (unacceptability) of destruction and disappearance of geological objects and systems that are classified as non-renewable resources, ethical collisions that arise in prognosticating geological calamity processes (eruptions, earthquakes, landslides, floods) etc.

Thus, determination of Geoethics as a science, classification of Geoethics into an independent philosophic discipline owes to Vaclav Nemec. He and his associated and followers from different countries specified the objectives of Geoethics, objects and targets of its studies. The international institutionalisation of geoethics was established in 2004, by forming a working group for Geoethics with the backing of the Association of Geoscientists for International Development (AGID). Therefore in 2008 Geoethics was for the first time incorporated in the official programme of the 33rd International Geological Congress under the auspices of AGID in Oslo, whereas the previous symposia to this object in previous Congresses were mostly based on a "private" initiation of Vaclav Nemec, Lidmila Nemcova and once also of Professor W.S. Fyfe (former IUGS President) [19].

However, despite the fact that more and more scientists have to some extent considered geoethical issues in their research works, Geoethics still looked a little-known scientific discipline. At its initial stage of development, Geoethics as a new scientific trend, it was important to formulate the notion "Geoethics" itself. Geoethics combines a complex of ethical problems, associated with geological scientific studies, practical geological exploration works, mining and use of mineral-raw resources, being one of the most important components of the natural environment, by preserving the geo-diversity and geo-heritage, by development and implementation into practice of professional codes of conduct. One way or another, but today all researchers agree with the fact that Geoethics is a notion that includes moral principalities in relation to the Earth as a geological body, and to social and economic objects in all their diversity [20].

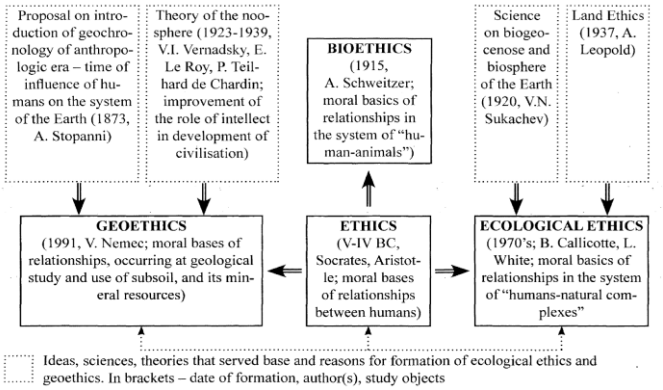

Figure 1: Basics and history of formation of geoethics (Source: Nikitina, 2016)

The incorporation, through Geoethics, of new key questions associated to the "abiotic world" is, besides widening the classical concept of Planetary Protection, giving an additional dimension to the geological research of the solar system (including the study of meteorites, asteroids, comets, planets and moons). The life in which these astronomical and geological processes culminate is still more impressive, but it is of a piece with the whole projective system [21]. Thus, inanimate objects and the abiotic processes of nature also possess objective value under Rolston's ethic [22]. To this end, the new planetary facet of Geoethics involves a new paradigmatic use of the term, extending the scope of the definition of Geoethics beyond the Earth (although maintaining the original Nemec's foundational spirit) [23]. Taking into account this additional perspective, the following formal definition of Geoethics is proposed: Geoethics is a key discipline in the field of Earth and Planetary Sciences, which involves scientific, technological, methodological and social-cultural aspects (e.g. sustainability, development, museology), but also the necessity of considering appropriate protocols, scientific integrity issues and a code of good practice, regarding the study of the abiotic world. Studies on planetary geology (*sensu lato*) and astrobiology also require a geoethical approach.

3. THE EARTH SYSTEM RELATIONSHIPS

A researcher conceived the earth as a *"great machine governed by a Supreme Principle"* that exists through a continuous and simultaneous competition including antagonism from endogenous agents, physical forces, chemical and mechanical properties, that *"are called to entertain what you can call globe life"*, but which also contribute to *"the biological forces order to maintain that wonderful circle in motion, that noble balance, so there is variety together with units.* The force that maintains the balance in the world, considering the complexity and the relational system that characterizes the Earth, is the continuous antagonism of natural agents.

Stoppani approaches the more recent Gaia hypothesis by James Lovelock and Lynn Margulis, that conceives the Earth as a single organism in which living and non-living things are connected to each other by negative retroactive processes that tend to maintain the stability of the main parameters that allow life on the planet [25]. Stoppani, albeit in the simplicity of his language and based on the knowledge of his time, seems to have launched the foundations for a modern approach to the study of the Earth system from a perspective of dynamic relationships between the various components of the ecosystem. This vision is now indispensable for environmental protection, proper management of geo-resources, evaluation and risk mitigation, all closely related with geo-ethical issues and common good (Fig. 2).

Figure 2: Sketch of the dynamic relations inside the Earth system and their interconnection and relationship with human's responsibility (Source: Lucchesi, 2017).

4. FOUNDATIONS OF GEOETHICS AND GEOETHICAL MISSION

The mission of Geoethics is in implementation of the values approach, values criteria in practice of geological exploration and mining activities, use of mineral resources and preservation of objects of inorganic nature (geo-heritage) as opposed to self-interest and (individual, corporate, state) mercantilism [26]. The object of study of Geoethics is morals in the field of study of subsoil of the Earth and other planets that contain mineral-raw resources, in the field of reproduction of the mineral-raw base, mining and use of mineral-raw resources and useful properties of subsoil, while the subject of its study are pragmatic sciences for starting from and surpassing the latter. Geoethics can fulfil the noble role of regulating the behaviour of people in the system of "human-inanimate nature". As a science about morals, Geoethics studies the process of motivation of behaviour, general orientation of relationships in the said system, justifies the necessity and most expedient form of the rules of joint existence of this system, which humans are prepared to accept and fulfill based on voluntary intention. Position and relation of Geoethics with other sciences is shown in Figure 3.

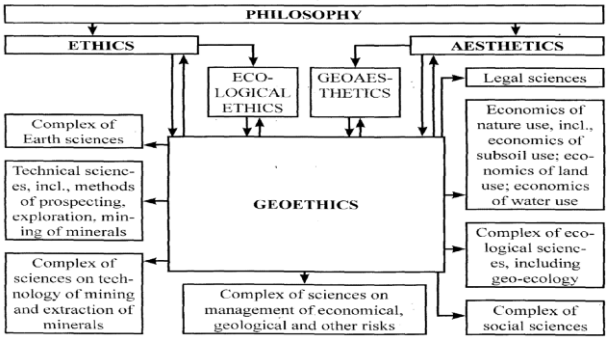

Figure 3: Interrelation of Geoethics with other sciences (Source: Nikitina, 2016)

Morals in the field of study of subsoil of the Earth and other planets, reproduction of mineral resources and their use as it is, occurs in the history of the society when there is a freedom of choice, possibility of fulfilling these processes in a different way, by preferring this or that system of valuables. Such choice is only possible in accordance with some ideas, on the basis of contrapositioning of "true" and "false" targets owing to establishing of understanding of the true mission of man by way of realising the position and role of humans in the nature system of the planet Earth. For the period of its existence, being a short time for a science, there are several practical justifications for expansion of the moral field to all objects of inorganic nature and all spheres of the Earth and other celestial bodies: lithosphere, hydrosphere, atmosphere, relief, landscapes, and the circumplanetary space. The subject of study of Geoethics is morals in the field of study and use of maximum large conglomerate of geological and geographical environments and their systems that cover any planet (and not only the Earth) as a single unit and that are combination of various parameters of inorganic nature, which are in close indissoluble connection, while on the Earth they are involved in the globalization process.

At the initial stage of formation of Geoethics as a scientific discipline (1992-2012), in the process of formulation of definitions, specification of objectives, purpose, objects and subjects of these categories, many scientists tried to maximize the extent of the list of each category, often, possibly, by incidentally including some objects and subjects of studies, purpose and objectives of ecological ethics. There existed another extremity. Some philosophers did not see any problems that could be resolved using already existing ecological ethics and directly refused Geoethics in its right for existence. It is possible that in near future all applied ethical disciplines, related with study and use of organic and inorganic systems of the earth, will be combined into a single science – something like the Ethics of the Earth [27].

The American futurologist, Jamais Caascio, is known for his works on prognostics and development of moral norms of future life. He defines the ethics of the Earth as *"a set of guideline principles, which should determine*

human behaviour and deeds that deal with large planetary systems, including atmospheric, oceanic, geological and ecosystems of flora and fauna. These guideline principles are especially necessary, if human behaviour and deeds may lead to long lasting, large scale and/or difficult to repair changes in planetary systems; but even local and surface changes should be considered through the prism of the Ethics of the Earth. The principles of the Ethics of the earth do not ban long term, large scale transformations, but require mandatory prognostication and accounting of consequences, including so called "secondary order effects", in other words undeliberate consequences, that are the results of interaction of the changed system with other connected systems" [28].

Geoethics is primarily based on perception of the planet Earth, its geological spheres, its subsoil, and all geological objects as the base of the life of humanity, on acknowledgement of equality and equivalence of inorganic matters, and on limitation of the rights of people in relation to inorganic nature. Within the framework of these new global ethical assumptions, humanity is trying to rethink the main issues of the entire complex of earth sciences. Combination of geoscientific problems (geographic unevenness of distribution of mineral deposits on the planet, exhaustion of mineral resources, constant growth of costs for discovery of such, natural and commercial risks for development, increase of the coverage area of protected natural territories etc.), main ethical achievement (responsibilities, rights and justice, responsibility of generation, religious beliefs in secular societies, etc.) and possibilities of such practical instruments like local and global geological knowledge, prognostics, scientific expertise of various projects and participation of citizens in decision making, allow formulating the following main geoethical postulates:

(1) natural, including mineral resources have specific internal properties that do not allow reflecting certain elements of their value in market prices or in any other similar utilitarian units of measure of value [29];
(2) geographic unevenness of distribution of mineral deposits on the planet requires using principally new global approaches to management and use of mineral resources, and to distribution of waste from development of such;
(3) exhaustion of mineral resources, limited volume and finiteness of such cause the issue of access, rights of currently living and future generations for mineral resources;
(4) the geography of world mineral resource mining is expanding: it at least depends on availability of mineable mineral deposits in a given territory, and it to larger extent is determined by social conditions and requirement of nature protection legislation of the given territory; moving mining centres to poorly developed counties has become a tendency;
(5) sustainable development assumes priority use of secondary resources, re-processing of which does not cause a destructive effect to all spheres of the Earth, which happens at initial (primary) extraction and processing of minerals.
(6) the nature, landscapes, biological diversity of species, subsoil should be treated not simply as objects of protection in the territory of mining and processing of minerals, they are primarily the objects of heritage for future generations [30].

4.1 The Facets of GeoEthics

GeoEthics has many important facets and explores four important dimensions:

(1) GeoEthics and Self: What are the internal attributes of a geoscientist that establish the ethical values required to successfully prepare for and contribute to a career in the geosciences?

(2) GeoEthics and the Geoscience Profession: What are the ethical standards expected of geoscientists if they are to contribute responsibly to the community of practice expected of the profession?

(3) GeoEthics and Society: What are the responsibilities of geoscientists to effectively and responsibly communicate the results of geoscience research to inform society about issues ranging from geohazards to natural resource utilization in order to protect the health, safety, and economic security of humanity?

(4) GeoEthics and Earth: What are the responsibilities of geoscientists to provide good stewardship of Earth based on their knowledge of Earth's composition, architecture, history, dynamic processes, and complex systems?

4.2 Microethics Versus Macroethics

Microethics deals with personal and professional ethics and can be tied to responsibilities at the personal and intra-professional level (e.g. an environmental consultant's ethical responsibility to providing their client with reliable data).

Macroethics deals with the ethics of a society or culture and can be tied to personal and professional responsibilities towards society (e.g. environmental consultants' responsibilities - as a profession - to ensure environmental stewardship in their professional conduct).

The understanding micro and macroethics and the interplays between them illuminates the roots of ethical thinking and behavior (why do we view things the way we do) and can help establish guidelines for ethical standards. The understanding of the interplay can help shift thinking and behaviors by getting to the roots of why we think and act the way we do. For example, taking action to reduce one's carbon footprint is tied to both microethics and macroethics. At a microethical level, our beliefs about the impact of humans on climate will influence our perception of responsibilities and stewardship and will guide us on whether or not to take actions such as driving and consuming less to lessen our footprint [31]. At a macroethical level, our professional responsibilities to be stewards to the Earth and abide by the high ethical standards set by society will influence how we conduct research and report data.

The subject of study of Geoethics includes geoethical situations, geoethical problems and geoethical dilemmas.

4.2.1 Geoethical Situations

This occurs when there are two different points of view in relation to the issue of what is acceptable or inacceptable in a specific situation. For instance, as a whole, geoethical situations occur every time when a decision has to be made on commercial developing of a mineral deposit, if there are two equivalent objects, there are two(or more) options of its development methods. A fair decision in such a case would be based on a complex analysis of existing geological, economic, environmental and other information, on assessment of the objectiveness, reliability and completeness of information, drawing of conclusions on the basis of the above to facilitate a correct choice.

4.2.2 Geoethcal Problems

These are more sophisticated than geo-ethical situations for they assume the presence of several possible ethical decisions. For determination of content and decision of the problem, it is necessary to have time and collective common sense to determine the best option out of all available decisions for all interested parties.

4.2.3 Geoethical Dilemmas

This occurs when, in any case, upon making any decision one of the sides incurs losses. For instance, for various reasons when local population acts against mining of mineral resources in the territory of their habitat. In this case, it is necessary to choose the least of several evils, for no decision would be good for all. Often, dilemmas are caused in crisis situations, for instance, during natural calamities.

4.3 Geoethical Principles and Imperatives

In moral geoethics system the main element is represented by the principles that determine the strategy of moral behaviour and its unconditional moral orientation in its general terms. The principles were formulated in different years by different authors mostly for allied sciences (ecological ethics, global ethics) and later introduced into geoethics, but all of these are based on the essential properties of mineral resources – deficiency (limitation), exhaustibility, non-renewability and belonging not only to currently living but also to future generations: *the planet Earth is primarily considered to be the absolute value of life*, and not as an object of industrial impact [32].

4.3.1 Principle of Sympathy

It is necessary to treat the problems of organic and inorganic nature from the point of view of "its interests" – normal existence of the natural, including geological environment, and humans, by avoiding egoistic or lucrative approaches [33,34].

4.3.2 Inter-relations Principle

No geosystems, planetary or local, do exist in isolines, and any change in any of these will inevitably lead to changes in another system of the same or higher level [35].

4.3.3 Principles of Harmony and Balance of Interests

The necessity of liaising/harmonizing interests of all social groups, related with use of mineral resources and useful properties of subsoil, by intruding into the geological environment, development of the mechanism of social accessibility of resources.

4.3.4 Principle of Responsibility in front of Future Generations and Increasing Variability

Any development should satisfy the needs of currently existing generation without any threat to the needs of other generations, and any taken decision for implementation of geoethical situations, dilemmas and problems should increase the possibilities/opportunities of currently living and future generations, and not degradation of such [36].

4.3.5 Principle of Forecasting

Analysis of possible changes should take into account not only the velocity of the processes of development of human civilization, but also the velocity of the processes of geological evolution.

4.3.6 Precautionary Principle

Any threat from any possible danger of natural, including geological, catastrophes upon taking management decisions should be taken into account as a really existing danger, even if such risk is of a preliminary scientific hypothetic nature.

4.3.7 Principle of Reversibility

The changes in geosystems of all levels, in the process of their performance must leave a possibility for taking a different geoethical decision in case of occurrence of unforeseen consequences.

4.3.8 Principle of Integration

The norms of ethical approach to inorganic nature should be introduced in laws, standards and rules of conduct of nations of the world. For comparison purposes, we shall demonstrate the main principles of ecological ethics that are established in the Rio-de-Janeiro Declaration on Environment and Development (Rio Declaration) signed in 1992 at an UNO conference

4.3.9 Principle of Respect to all Life Forms

That affirms the value of each living creature: "any form of life should be respected irrespective of its usefulness for humans", "each organism, whether human or else, whether it has a capability of feeling or not, safe for humans or not, is a value itself

4.3.10 Biodiversity Principle

That affirms the value of biodiversity and necessity in its preservation

4.3.11 Principle of Maintaining Sustainability of Biosphere

That are the basics of sustainable development

4.3.12 Principle of Ecological Justice

states equal distribution of the rights for ecological safety between humans; and everybody is imposed responsibility for its preservations

4.3.13 Precautionary Principle

According to which, it is necessary to primarily take into account most dangerous possible development of events while developing a policy that directly or indirectly impacts to ecology.

4.3.14 Principle of General Ownership to Natural Resources

Expresses the understanding of the Earth as an integral unity; according to this principle, people carry equal responsibility for natural resources.
A researcher introduced the term "ecological imperative". The scientific circles immediately started discussions that are still ongoing, about valuable-normative bases of the ecological imperative and fields of its application. Despite wide use of this term, its content is not yet fully developed. Its use often occurs in the context of general calls of ecological alarmists ("do not cause damage to the nature") and does not carry any moral-ethical content. A researcher defined it as "a system of limitations, violation of which may cause irreversible consequences.

A previous researcher introduced *the principle of moderateness* (*the principle of "do not damage"*) in geoethics based on the ecological imperative: actions in relation to geological objects and geological systems of any level should by all means avoid causing damage. However, this direct borrowing from a discipline that is "allied" to geoethics is still within "alarmism" ideas.

5. GEOETHICS AS AN IMPORTANT AREA OF RESEARCH

Geoethics as an important area of research and reflection has an overall aim that all geoscientists work should be integrated into their education and continued professional development. The *'10 fundamental values'* expressed in the Cape Town Statement on Geo-ethics (CTSG) help articulate what it is that we as geoscientists could (and should) be doing if our professional engagement with one another and society is to be considered 'ethical' according to Fundamental Values of Geoethics, Cape Town Statement on Geoethics (CTSG):

(1) Honesty, integrity, transparency and reliability of the geoscientist, including strict adherence to scientific methods;

(2) Competence, including regular training and life-long learning;

(3) Sharing knowledge at all levels as a valuable activity, which implies communicating science and results, while taking into account intrinsic limitations such as probabilities and uncertainties;

(4) Verifying the sources of information and data, and applying objective, unbiased peer-review processes to technical and scientific publications;

(5) Working with a spirit of cooperation and reciprocity, which involves understanding and respect for different ideas and hypotheses;

(6) Respecting natural processes and phenomena, where possible, when planning and implementing interventions in the environment;

(7) Protecting geodiversity as an essential aspect of the development of life and biodiversity, cultural and social diversity, and the sustainable development of communities;

(8) Enhancing geoheritage, which brings together scientific and cultural factors that have intrinsic social and economic value, to strengthen the sense of belonging of people for their environment;

(9) Ensuring sustainability of economic and social activities in order to assure future generations' supply of energy and other natural resources.

(10) Promoting geo-education and outreach for all, to further sustainable economic development, geohazard prevention and mitigation, environmental protection, and increased societal

resilience and well-being. (Source: Fundamental Values of Geoethics, Cape Town Statement on Geoethics).

6. CHALLENGES AND PROSPECTS OF GEOETHICS

The major challenge for our generation is to develop tools and organizations that will enable mankind to cease its current predatory approach to the Earth's natural resources and create a climate of stewardship. This requires that ethical work use both fundamental (providing resources for thoughts and beliefs concerning what represents true happiness, real wealth, actual value and applied approaches. All sectors must be mobilized, both secular-to develop information, education, justice, public debate, combining both responsibility and "interrogativity", and religious - not for evasive, apocalyptic or sectarian approaches but for their message of love of the world. The need for a paradigm shift (of opinions, habits, perception, etc.) is such that, in addition to a 'scientific revolution" (a new spiritual work - religious or artistic - is necessary in order to shake up the social imaginary and provide answers at the level of the global questions raised [37].

While the anthropocentrism of today's western culture is rooted in the Age of Enlightenment and the Christian Reformation, we might also find in Franciscan frugality and Calvinist sobriety a regeneration of modernity based on a renewed solidarity, a fraternal sharing of the earth's goods and burdens, a redistribution of knowledge, duty and pleasure. We should seek an affirmation of transcendence that generates a 'course of recognition" (Ricoeur), thanksgiving for natural and human resources, respect for the plurality of the world's inhabitants, and an ethical anthropocentrism capable of taking steps to look after and saving our fragile world.

The challenges for ethical criterion for geoscientists according to a researcher should include the following [38]:

(1) Respect for the truth as we look for our own ideas and for other's ideas;

(2) Recognition of the value of others;

(3) A spirit of collaboration and reciprocity;

(4) Identification of a common goal, despite the diversity of views;

(5) Responsibility derived from our technical-cultural expertise;

(6) Being opened to criticism and ready to question one's own certainties;

(7) Reflection on the mutuality of knowledge and roles;

(8) Awareness that conveying scientific knowledge to others is valuable.

Geoscientists should put heads together to ensure that geoethics becomes fully a fundamental area of research [39]. It is necessary at this early stage of development of this emerging discipline, to try to develop a systematic approach with two objectives. One would be to enable a better organisation of future research work (symposia, papers, web chats etc). The other would be to attempt to establish a hierarchy of geoethical problems in order to set priorities answering as well as possible the needs of society. In case of success, this could help for a try to promote a joint message from concerned circles which would be audible for the society. As a feedback, the expression of the societal demand could better emerge.

Ethics helps to distinguish the problems and values involved in a given field: What are we doing, and what do we really do? Does it fit with what we want? And do we want what we believe? Ethics should help us formulate possible and preferable solutions. Sometimes it may help only by pinpointing a dilemma. As a rational approach, ethical analysis should help us identify issues as systematically as possible, provide a basis for reflection, and prepare for and enable responsible decision making. Therefore, the identification phase, in which the crucial questions are raised, is in itself essential.

Ethical analysis, besides leading to responsible decisions and correct acts, may also lead to a more profound examination of the meaning of life and the significance of being human. Ethics here touches on anthropology. In our quest for good behavior, we are seeking to "do justice to humans" [40]. Our acts commit us and reveal underlying dynamics [41-49]. Our acts translate our attitudes, attentions, attempts. Therefore, ethics touches on spirituality in a broad sense, because our inner life and our "outer" life are in resonance and permanent interference. Of course, this is not easy, as we must constantly distinguish between anthropologic, ethical and spiritual approaches, while avoiding compartmentalization, as if they had no effect on each another [50-56].

7. CONCLUSION

Ethical behavior is essential to science, whose purpose is to develop reliable knowledge about the physical world based on reproducible observation and development of testable explanations. There is no science without honesty, and truth telling is a fundamental ethical virtue. There is an ethical element present in even the most basic scientific observations. The interest by geoscientists in (geo) ethical aspects of geoscience knowledge, education, research, practice and communication has grown considerably. Today the topic of geoethics has gained a significant/tremendous visibility within the scientific community. The International Association for Promoting Geoethics (IAPG) founded in 2012, has worked to widen the discussion and create awareness about issues of ethics as applied to the geosciences. Thanks to continuous voluntary work, the respectful exchange, and fruitful sharing of ideas, the IAPG community has produced a conceptual substratum on which to base the future development of geoethics, by clarifying the meaning of the word "geoethics", formalizing its definition, and better identifying a framework of reference values on which the geoscience community can base more effective codes of conduct and guidance.

The IAPG considers the 35th IGC as the scientific event that opened a new phase for furthering the concept of geoethics. Also, the Cape Town Statement on Geoethics (CTSG), released officially on October 2016, is a document that defines a conceptual framework for the study of geoethics, and provides a first step to exploring whether geoethics could evolve into a new discipline, either within geo-sciences or within ethical sciences. The true development of geoethics is, above all, a responsibility of all of us as Earth and Planetary Scientists. Geoethics is a discipline in full growth and in recent years many ideas have been planted in hopes that they would sprout. The results obtained up to now are encouraging. To this end, with the progress of science and technology and with questions arising on globalization, ethical issues, in particular geoethics, concerns us all. More importantly, teaching geoethics could help students to understand the ethical dilemmas of geosciences and to develop strategies to address sustainability issues. In this way, early immersions in the learning of geological abilities linked with other transversal disciplines can outline long-term attitudes toward the interdisciplinary, beyond the mere geological work. Indeed, the geoethics arena may be the space in which we can discuss and share those values that will help to develop a healthier relationship between humankind and the planet. More importantly, Geoethics is an orientation tool for geoscientists, able to provide geoscientists with the ethical dimension of their actions. To this end, geoscientists must be able to face the enormous challenge of reconciling geoethical values with the practice of geosciences. With this aim in mind, geoscientists must be able to function without making compromises in their work, undertake the pursuit of the common good, and ensure the right balance between sustainable living conditions while respecting Earth processes.

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