Luis Ricardo Fernandes da Costa
(Organizador)

GEOCIÊNCIAS:

Desenvolvimento científico, tecnológico e econômico

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APRESENTAÇÃO

É com muito prazer que apresentamos a obra “Geociências: Desenvolvimento científico, tecnológico e econômico 2”, que apresenta uma série de doze artigos com diferentes propostas de análise espacial, com ênfase em estudos aplicados ou de cunho metodológico.

A obra é composta por trabalhos voltados para as geociências e que abordam diferentes perspectivas, desde análises voltadas para a dinâmica das geociências, passando pela importância dos estudos de impacto ambiental em áreas urbanas, além de estudos em bacias de sedimentação, mineração e impactos de inundações em diferentes ambientes.

Como destaque, cabe ressaltar a aplicabilidade em diferentes contextos e realidades no país. Diante dos desafios e atual conjuntura da ciência brasileira, a presente obra é uma possibilidade e esforço de divulgação de trabalhos com diferentes abordagens e perspectivas de análise nas esferas das geociências.

Convidamos a todos os leitores a percorrer pelo sumário e conferir o novo volume para essa coleção, com possibilidades de expansão e disseminação nos próximos trabalhos da área.

Luis Ricardo Fernandes da Costa

SUMÁRIO

CAPÍTULO 1

A PERSPECTIVE FOR GEOSCIENCE EDUCATION TO IMPROVE THE FUTURE OF HUMANITY

Data de aceite: 01/11/2022

Guilherme O. Estrella
Geologist, graduated in Rio de Janeiro Federal University
Retired, worked his entire professional life (45 years) as petroleum geologist in Petrobrás, Brazilian State O/G Company, in which was Exploration and Production (E&P) Executive Director 2003-1012.

ABSTRACT: Humanity faces tremendous problems. We have experimented a vast social, political, ethical, economical, scientific and technological evolution along the past millennia. However, we are far from living in peace, with minimum social equality, acceptable living standards, respect for human rights, access to basic natural resources, democracy, religious freedom, diversity, environment, planetary biota. We have to find a way to overcome these difficulties. There is no doubt that education is in the center of the solution, but not the formal education system we traditionally apply. Some authors consider the scientific-humanities illiteracy as the main challenge for human beings to take a more advanced — in all dimensions of the human life — step towards civilization. Geology, among the broad spectrum of human knowledge, seems to be one of the sciences which best deals with both the scientific and humanities concepts, facilitating the understanding of unity of our planet, as well as our responsibility to take care of the natural environment and provide conditions for the survival all species. It is in the childhood, since the first lessons, that basic principles of geology have to be taught, to allow individuals to build their personalities with these concepts firmly established.
KEYWORDS: Geology education in childhood, science, humanities.

1 | INTRODUCTION

Let's to evaluate data about the world we live in. Social and economical aspects:

1. World population = we are 7.6 billion human beings. We will be 10 billion by 2050.

2. 800 million starve – an increase of 40 million from 2015 to 2016.

3. 155 million children under 5 (five) starve or are submitted to severe undernourishment.

4. 4,5 billion people lack basic sanitation.

5. 2.1 billion have no acces to drinking water.

6. 1.4 billion do not have acceptable housing.

7. According to UN 2017: 260 million children and teenagers are out of school.

8. After years falling, child labor rates increased again in 2018: 152 million children engaged in child labor, 110 million of them in agricultural work (FAO).

9. 1.3 billion people have no access to

electricity.

10. According to UN, 900 million or 12% (twelve percent) of world population) practice open defecation.

11. 1 million of nurslings and children die before five, per year: 99% in poor and developing countries. 49/1,000 live births.

12. 800 million of people are illiterate adults (over fifteen years old). Among youths worldwide, 1 billion have no access to education.

13. There are more than 40 million slaves world- wide; more than 70% being women.

14. Child prostitution reaches 1 million children. In some countries 50% of prostitutes are children. 2 million teenagers have HIV.

15. There were 66 million refugees in 2017, 50 % are children (ACNUR).

16. Only 1/3 of the countries – 28% of the world population – assure social protection from the state – health, education, housing – to their citizens.

17. On the other hand, wealth of richest 1% equal to other 99%. The richest person on this planet owns wealth which is bigger than the GDP of 140 countries.

18. Walls: today, 65 borders between countries across the world are defined by walls, isolating peoples, societies from one another by political, economic, social, ethnic and religious reasons.

About environment and nature:

1. Species extinction in 2014: 784 animal species were extinguished in the past 40 (forty) years.

2. Deforestation: 3.4 million km2 deforested in the past 16 years.

3. Russia + Brazil: Taiga and the Amazon forest suffer a fast paced process of devastation.100,000 km2 in 2017; Canada + the USA = 50,000 km2 in 2017.

4. The world consumption of natural resources and energy can triplicate by 2050 and generate a catastrophic impact on the environment. The present consumption standards, mainly in the Occident, are not sustainable.

5. More than 100 MM ton of floating plastic garbage only in the Pacific Ocean.

This is an unacceptable reality.

One first conclusion: from these data, we can´t deny, neither try to hide that the political regime models of humanity governance and the current instruments and global multilateral institutions – UN, IMF, WB, WTO, FAO, ILO… – are clearly outdated.

They are not ready to recognize cultural diversities, to fight against racism, colonialism, sexism, discrimination, the prejudices and the huge social inequalities that are at very heart of their own origin as world organizations.

Also, regarding environment protection, they failed to present and adopt effective solutions of any type. The Paris Convention was recently abandoned by the richest country

of the world.

The irresponsible use of fossils fuels is not restricted by the main industrialized countries.

Whale commercial fishing is unstoppable, even by so the called most culturally advanced countries.

We are all, as humankind, facing a totally unsustainable situation.

But it can be even worst, as the forecasts on industrial activities show.

Industrial revolution 4.0: automation, integrated and interconnected production systems, artificial intelligence, self-aware robots, telecommunication. It is estimated that on the next decade 5 million jobs will be lost in OEDC countries and 15 million in developing countries.

Today's social, economic, political standards of organized societies, all of them across the planet, will have to be deeply changed.

Academic scholars state that mankind should be reinvented to face this reality. The XXI century is the time of a great leap for humanity.

But there is a light at the end of this ghostly tunnel: telecommunications and related technologies.

Some world data:

1. Internet (2018) = more than 4 billion people (53% WP) - doubled in 8 years.
2. Social networks = 3.2 billion (42% WP).
3. Mobile phones = 5.1 billion (68% WP).
4. Mobile internet = 3 billion (40% WP).

Internet can certainly be – as we already are experiencing worldwide – a decisive tool to face the challenges we have in front of us.

Finally, Marshall Mc Luhan's Global Village prophecy is materialized.

People are connected, in real time, discussing problems, necessities of real participation in decisions of all kinds taken by governments around the world. People mobilized by mobile phones are occupying public spaces from Sydney to Oslo, from Buenos Aires to Moscow, changing the world, continuously.

2 | THE IMPORTANCE OF SCIENTIFIC DISSEMINATION TO ORDINARY GLOBAL CITIZEN

The second part of this reflection is based in a 2011 publication of Bahia State Federal University (1) withthe title "*Diálogos entre Ciência e a Divulgação Científica – Leitura Contemporânea*" (Dialogues between Science ant the Scientific dissemination – contemporary readings).

People and citizens interacting with the C&T themes, at present times, called

"scientific culture" – play an important role in contemporary societies' political, social and economic life.

The ordinary citizen, at last, becomes the main addressee of the scientific culture dissemination main addressee.

The knowledge and the scientific culture are the promoters of the critical citizenship formation with scientific work resulting in the social well-being of the global population, which involves principles and civilizing ethical values, in addition to attitudes, habits and information.

The consolidated access to scientific information concept is vital, but, more important indispensable to the complete of the participatory citizen, embodies ethic, social, politic, economic, and corporative concerns and imposes that the disclosure of C&T transcends its academic circle and effectively reaches the whole society.

Social behavior is greatly influenced by knowledge, which enables the individual to understand and criticize the society and claim and strive for changes.

In other words, searching for the continuous improvement of the quality of life with the support science is a recipe for a commitment to the development of true citizens and to their participation into the positive transformation of the social and cultural relationships of all humanity.

The austro-english phylosopher Karl Popper [1902- 1994] stated that:

"Civilized citizens aren't the product by chance, but actually an education process". Another reference is made to the French philosopher Michel Foucault (1926-1984): "There is no neutral knowledge, all knowledge is political".

Science and technology are closely related to citizenship and democracy. The mobilization of people begins at knowledge acquisition.

So, science, education and the formation of a science culture are, above all, a transforming step, favorable to the individual, necessary cognitive and critical resources essential to his/her participation in the society.

The reverse of this is the "scientific illiteracy", whose consequences are much more dangerous today than in the past because nowadays people are stimulated to have a much more intense participation in the society's life.

Ordinary citizens are threatened by their ignorance of the true causes of issues humanity faces today, produced either by ourselves, human beings, our actions (ethic, social, politic), or natural unavoidable phenomena resulting from the constant 5 billion year old transformation process that affects planet Earth, like global warming.

We all should be ready to solve and to avoid the former and to attenuate the impact of the latter on human- kind.

This depends upon the scientific/humanistic information common citizen access to. Instead, the so-called "scientific literacy" has been facing difficulty to perform, since this idea of bringing the science to the ordinary citizen was first mentioned in the XIX century.

Scientists have not-succeed in achieving the goal of building a widespread scientific culture in mankind, we must admit.

Why?

Many difficulties are encountered in the process of building of a scientific culture in society.

Common citizens think that science and humanities are subjects, concepts and visions which are only relevant to scientific and humanities communities.

So, they did not learn to link science-humanities to their lives and, as a result, they are not comfortable to think over the world, the society where they live in.

On the contrary, common people are easy targets to the mass media, representing, in general, great political, financial and ideological interests.

So, common citizen are convinced since childhood, of non-civilizing anti-values and absurd anomalies as, for instance, the division of human beings in winners and losers.

It is necessary to promote people's interest and convert the airtight scientific language into an accessible, light and pleasant message to the ordinarycitizen.

Transforming the science into something as culture and social as art.

We have to perceive the scientific field based on the view of inserting it into the social, political and economic context.

An issue that has persisted for a long time, and needs to be discussed: the division between natural sciences and humanities, in order to identify, between them, areas of synergy.

It has been common to accept a bipolar distribution between nature and physical sciences and the humanities.

There would be an insuperable abyss, sometimes with hostility and aversion between these two disciplines of human knowledge.

The pure scientific culture is intrinsic to the western culture displayed as outdated, with a single base of human rationality.

Over the last decades, however, interdisciplinary and multidisciplinary fields stand out in many scientific areas, which have, in their structure and in their origins, elements that eliminate the barriers between the two cultures, the natural sciences and the humanities. Hence, the scientific fields most suitable to serve as a basis to rouse the curiosity of individuals, are suitable and effective tools to overcome scientific illiteracy and to build a scientific/humanistic culture.

This is extremely important now, when we reach a very special and decisive moment in mankind history: not only because humankind is facing a long list of ethical and social problems, but an extraordinary scientific-technological development and a new industrial revolution.

It is not acceptable anymore that humankind perseveres in such human tragedy, criminal extinction of other species and environmental havoc of large proportion.

Responsible global citizens, worldwide, must play a crucial role so that its implementation shall be pro people not impairing them.

There is neither place nor time for wishful thinking.

Science and technology and the forthcoming industrial revolution must, compulsorily, contribute to the general well-being of all human beings. However, it will be different if conscious citizens do not engage and fight against the status quo it will deepen the humane tragedy context that we see nowadays worldwide.

In an article – published in 2006 – by the magazine *The Futurist*, of WFS (2), Ray Kurzweil foresees, with great optimism, the future of humankind as result of the extraordinary scientific & technological developments, at that time already in progress. Other authors, however, do not agree.

They state that, historically, science and technology have not always promoted social and economic advancements for the majority of mankind.

They defend human life comprises a lot of experiences and emotions much more important than the simple material fruition promoted by the scientific and technological development.

Some time ago, in an interview (3) to a Portuguese newspaper, the Italian philosopher Franco Berardi warned about the threats humankind will face in the future.

He focuses on the very negative aspects the financial ultra-capitalism is bringing to humankind, mainly in the western world, associated with the forthcoming industrial revolution.

But the 4.0 revolution has brought about the worldwide computational science and dissemination of internet.

The fantastic proficiency in providing, in real time, to interconnected people worldwide the ability to discuss problems and find solutions, has created the basic conditions to raise the global citizenship.

Internet and electronics are the perfect tools to be used to take the scientific-humanistic culture to the global common citizen, wherever he/she lives on the planet.

3 I BENEFITS OF TEACHING BASIC KNOWLEDGE ON GEOLOGICAL SCIENCE TO ORDINARY PEOPLE

It is easy to accept basic scientific/humanistic knowledge spreading since childhood – of course according to specific didactic tools – will be an effective, enriching contribution for the formation of future responsible citizenship, in spite of children may have contact with anti-civilized visions and attitudes throughout their lives until adulthood.

Thinking in the near future, it can seem unrealistic, but it is possible to build a new scientific culture through the scientific literacy, which should begin at school, since the early stages of life, in childhood.

The role of schools role at the elementary level for the formation of this “scientific

culture" is crucial.

The extraordinary communication capabilities that electronic tools enable in the modern education systems are splendid to teach children.

The challenge is to create an educational system that rouses the curiosity of children and teenagers and keeps their motivation levels up to promote lifelong learnings, creating civilized citizens in every sense.

That said, let us try to imagine why and how Geology can contribute to the dissemination of a scientific-humanistic culture in humankind, and, very importantly, focusing our children.

All it will be discussed here, is perfectly known by geologists.

As far as I'm concerned it is not difficult for us, geologists, to realize the importance of our contribution.

First of all, because Geology is – maybe a rare exception among all scientific spectrum – a multidisciplinary science, markedly interdisciplinary, to represent a concrete "bridge" between the scientific and humanistic cultures.

Besides that, Geology brings to all scientific statement two basic concepts to understanding the phenomena, along with eventually related problems and, very importantly, the solutions considered to be applied: time and the continuous, unstoppable transformation process our planet is submitted

This statement, presently accepted with relative ease in scientific circles, largely comes from Robert Frodeman's extraordinary work "Geological reasoning: geology as an interpretative and historical science" (4).

Frodeman confirms this form of Geology when defends – ex-cathedra – that geology is not a science that comes only from logic techniques, such as Physics. He states:

"the geological thinking developed its own set distinct of logic procedures – what actually embodies a different methodology in the sciences context and offers a global model – better than physics – to understand the reasoning logic into sciences and daily life."

In subsequent work, equally a benchmark, (5), Cervato & Frodeman take up the impact of the sense of geological time prints in the mankind history analyses, with cultural, educational and economic consequences in the society.

Geology is not only the science that deals with the past of our planet, as it can be thought of by ordinary people.

Geological science attempts to explain and to predict natural events involving changes to the natural environment and threats to human beings. Geology tries to predict natural "disasters" to people, so far with little success, as per recent, astonishing lava flows in Hawaii.

Geology is a scientific-humanistic base for knowledge and reflection – ethical, ideological, political, social, economical, technological – not only our future, but also of our responsibility on the preservation of the environment and other living beings on the planet.

This is Geology.

To eliminate the scientific illiteracy – it's worth remembering – some messages from Geology can influence civilizing formation of the new global citizens, mainly when information is delivered to them in the childhood.

The most important and leading message is that planet Earth is integrated in a unique space, everywhere, in spite distances.

In addition, the Earth is a "living organism", inasmuch as it has its own ways and processes to change, to transform and to evolve by itself.

That is the way it always been since its inception, about 5 billion years ago.

Plate tectonics promotes a scientific understanding of our planet upon an unified, consolidated view of the Earth history as an integrated system of dynamic forces that permanently shapes the planet's surface.

An earthquake in New Zealand, in the South Atlantic is immediately greeted for new fumaroles in Stromboli, in Aeolian Islands, in the Mediterranean.

All inhabitants on this planet live in a whole and unique one place. So, we are all together.

The New Zealander who feels the earthquake is not different from the Italian who records the fumaroles in Stromboli, neither from the Brazilian in Copacabana Beach, that is drifting apart from Africa by 2 cm per year. All these phenomena result from plate tectonics and sea floor spreading, scientific base for Geology.

Regarding life itself, plate tectonics has brought to us an extraordinary meaningful contribution.

It links every living beings, the entire Earth's biota, at the origin of our primordial own life, which emerged on this planet, around of fumaroles, from the deep ocean trenches, over 3 billion years ago.

Geology teaches us all living beings on this planet – humans, animals and plants – have the same, single origin.

This scientific knowledge - concerning the planet Earth as an integrated "organism", since its formation, submitted to an uninterrupted transformation process - could to be accessible to people to develop a sense of **belonging** our planet. And this learning will be much more effective and permanent for life if taugth since early childhood.

As a direct, immediate and inescapable of this feeling, the consciousness that benefits from the exploration of **all** Earth's natural resources - since they were not built by human beings but by a natural billion year process - must be allocated to all of us, not to a privileged part of the humanity.

Furthermore, having in mind that the Earth's natural resources are finite, they are not renewable, we have to explore them under the conservationism's ethics.

Our planet does not distinguish us, neither isolate us. On the contrary, it belongs to us, it joins us, we are all the result of its permanent evolution

Specifically concerning about our species, *Homo sapiens sapiens*, the same occurs.

We, human beings, homo sapiens sapiens, are all descendants from the same group of dwelling anthropoid primates in Africa, around 350 000 years ago.

After a continuous evolutionary process, human beings have acquired advanced intelligence, extreme cognitive capacity, irrepressible vocation to reflection about the significance of life, about the planet, the Universe. And an infinite innovation power.

This scientific statement is the inescapable truth:

“We, all human beings have the same sole origin, we live in the same home, we are all equals, we are all siblings. Nothing separates us, everything unites us.”

Someone already say, with remarkable wisdom: “ we need bridges, no walls.”

This fact imposes to us – as infinitely the most intelligent of the entire earth’s biota and, as a consequence, hegemonic species – therefore, the ethical obligation to respect, defend and keep the survival of all living beings remaining on our planet.

Under the environmental viewpoint it is the same situation: the criminal firing of South American Amazon forest and the incredible devastation of taiga – Russia, impact the climate of the whole planet, which will affect everybody, from Artic Greenland Eskimo to the Brazilian Yanomani living inside the dense equatorial forest.

The central, most important message is: planet Earth is the common home, for all of us, human beings and all the other beings living on it.

We share the same destiny.

Humanity built a continuous process which requires general and unrestricted acceptance of principles and values which are beneficial to the preservation of life, to the equality for all, to the right to live in dignity, to rights and duties we established in order to promote what we call **civilization**.

Geology, and just Geology, can bring to us this awareness. This is not a naïve statement.

This is Science.

It is easy to understand this message for those who regularly deal with science.

But for common people, who commonly are scientifically illiterate, this can be difficult.

So, this essential geological information, from a scientific-humanistic culture, has to reach everybody, worldwide, as soon as possible, mainly in the childhood

Geology can, effectively, contribute to the eradication of scientific–humanistic illiteracy of all citizens on this planet and to the formation of a true global citizenship, with civilizing principles and values and consciousness of their ethical, political and social responsibilities of mankind, in harmony with all other living beings and the environment.

The perception of our full responsibility towards the planet Earth, as a whole, is revolutionary.

It is the foundation, the bedrock, literally, to promote the constructing of a new, civilized humankind.

Everyone, all human beings, without exception, have the right to freedom, full

increasingly participatory democracy, decent life, with equal opportunities for all to live in a planetary society without hate, prejudices and exclusion.

It will be our today's children, who – as adults in the near future, the true and effective global citizens – will fully understand and take responsibility on behalf of all humankind, for the70 year old *Declaration of Human Rights* (UN 1948,(06) and the *State of the Planet Declaration – Planet Under Pressure*, 2011 (7).

Last but not the least, is time for global citizens to understand the meaning and be acquainted with the term "Anthropocene".

We, human beings, are over 7 billion living on planet Earth.

An animal species with unbeatable power to influence, interfere and transform the natural environment.

Geological time is divided from the beginning in eons, eras, periods and epochs. Concerning life, informally, there are "ages" of invertebrates, amphibious, reptiles and mammals.

But, as in relation to the evolution of species we, homo sapiens sapiens, are so immensely different from other animals to the point of interfering on natural environment that, in 2000, Paul Crutzen, dutch Nobel Prize winner in chemistry, proposed the denomination " Anthropocene" to this period we are living, whose beginning is defined around 10,000 years ago, the end of last glacial Earth's age.

So, it's critical that human beings understand that the Earth is in an interglacial time and how our actions on Earth influences, for instance – only to make reference to a big environmental problem humanity is presently facing – the global warming.

First of all, the global warming is a natural, geologic, unstoppable phase of Earth's history.

But, there is no doubt human beings actions have an impact in it.

There are different scientific opinions not about the geologic warming age but about how much human action is part of it.

Big or small, human beings can contribute to attenuate the negative effects of global warming on people's life.

4 | CONCLUSION

The knowledge of basic Geology can, effectively, contribute to the understanding of this process and to the construction of a really civilized humanity.

Much better if, since the childhood, we learn about.

If this is accomplished, Geology, as science will have finally fulfilled its mission – as all other Sciences – just for the benefit of mankind.

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