ABOUT THE GEOGENIC FLUOR ELEMENT AND DENTAL FLUOROSIS IN THE STATE OF BAHIA, BRAZIL

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ABSTRACT

The findings between the relationships between the geological/geochemical environment and the health of populations, based on the effect of the chemical element fluor of geogenic origin present in the groundwater of several locations in the State of Bahia, Brazil present numbers that indicate values of the order of 0.4 mg/L F, as a risk to populations, 0.4 to 0.8 mg/L F as a protective factor and >0.8 mg/L F as a myth prone to dental fluorosis.

Analyses of water for human consumption, in particular fluor concentrations, represent an important planning and decision-making tool for managers and municipal bodies regarding water fluoridation and the presence of natural fluoride. The results presented can promote prevention strategies for a series of diseases, including dental fluorosis and highlight, in a striking way, the importance of geogenic materials and the health of populations.

KEY WORDS: Water fluoridation, Dean´s index**,** Medical Geology

1. INTRODUCTION

Medical Geology is the science that deals with the impacts of geological materials and processes on animals and human health (Burnnell et al. 2007). Consequently, Medical Geology began to require geoscientists and biomedical scientists and public health managers to become concerned with health problems caused or exacerbated by geological materials such as trace elements, rocks, minerals, water, oil and geological processes.

The village of Cruz is a small district in the municipality of Jussiape, south-central portion of the State of Bahia, Brazil, starting in 1985, the state government, aiming to improve the quality of life and health of the community, initiated drilling of tubular wells to capture groundwater and the construction of reservoirs for the accumulation and better

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distribution of water. In addition to searching for quantity, water treatment and fluoride enrichment were carried out, following the instructions of the human health departments.

The municipal prosthetist, known as *Sete-Cordas*, due to his skills in playing the guitar, from the late 1990s onwards, began to be sought after by the community of Cruz, with complaints of stains on the teeth of children and adolescents, with his In a particular case, Mr *Sete-Cordas* identified the very important presence of a dental disease, which affected the community and determined the existence of a focus of dental fluorosis in the municipality of Jussiape. He also piqued his curiosity in determining the cause of this dental disease, which, apparently, until that time, had not been detected in the region.

Dental studies characterize the mineral content of tooth enamel as being composed of hydroxyapatite crystals, which are distributed to form enamel prisms. Between these prisms, there are gaps (interprismatic), through which the enamel fluid circulates, forming true circulation pathways for this fluid and establishing a diffusion pressure from the enamel to the saliva and vice versa. Whenever there is the production of acids, especially lactic acid, resulting from bacterial metabolism, calcium (Ca^{2+}) and phosphate (PO_4^{-3}) ions will leave the hydroxyapatite crystals. Thus, there is an increase in the concentrations of these ions in the enamel fluid and, through diffusion, there will be a tendency for these ions to leave the enamel and diffuse into the saliva, developing demineralization. On the other hand, when the concentration of Ca^{+2} and PO_4^{-3} in saliva is greater than that of the enamel fluid, the flow of ions occurs in the opposite direction, that is, from the saliva to the enamel, causing a remineralization.

Fluor has its main benefit on human health based on the possibility of interfering in the process of formation of tooth decay, inhibiting demineralization and activating the remineralization of the enamel-dentin complex, through chemical reactions that occur on the tooth surface. When there is a fluorine concentration of around 1ppm in the environment, it acts as a catalyst for the process, and remineralization will be accelerated by approximately 5 times (Buzalaf, 1996).

Dental fluorosis originates from the exposure of the tooth germ, during its formation process, when subjected to high and frequent concentrations of the fluoride ion, producing defects in the mineralization of the enamel. During amelogenesis, high doses of fluoride will delay enamel mineralization, affecting the growth of apatite crystals; fluorine is incorporated into the mineral replacing hydroxyl, thus reducing the volume of newly formed enamel (AOBA, 1977).

The criteria for identifying levels of dental fluorosis are made by applying the DEAN index, (1934), recommended by the WHO, (1997) (Table 1). Added to this data are some images from the important photographic study by Coutinho, (2014).

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Table 1 – Index DEAN (1934), recommended by the WHO,(1997) (apub Coutinho,2014)

Classification	Value	Diagnostic Criteria
Normal	0	Absent fluorosis. The enamel has usual translucency and semi-vitriform structure, the surface is smooth, polished, light cream colour
Questionable	1	The enamel has a slight difference in relation to normal translucency and occasional whitish spots. Applicable if *normal* classification is not justified
Very light	2	There are small, opaque, whitish spots that spread irregularly across the tooth (<25% of the surface). Includes clear opacities between 1 and 2 mm at the cusp tip of molars (snowy)
Light	3	White spots occur and opacity is more extensive (<50% of the surface)
Moderate	4	White spots occur on more than 50% of the tooth surface and wear is observed along with small brown spots. All tooth enamel is affected and areas subject to friction appear worn. There may be brown or yellowish spots, often disfiguring
Serious	5	Hypoplasia is widespread and the shape of the tooth itself can be affected. The most obvious sign is the presence of depressions in the enamel, which appears eroded. Generalized brown spots

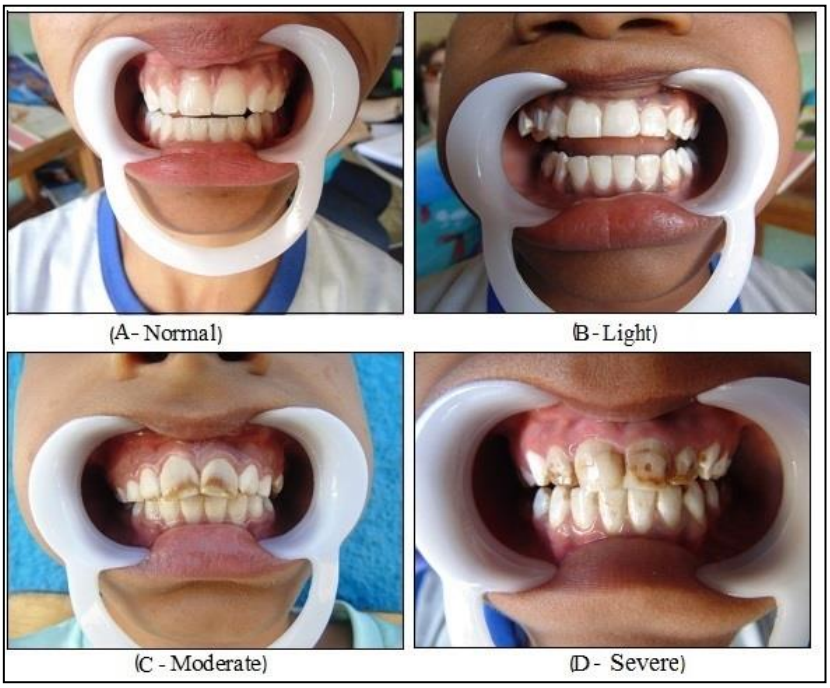

Figure 1 – Photographic study by Coutinho, (2014), to use the DEAN index, (1934).

This article aims to disseminate to the scientific community and government circles, in light of the current state of the art, the findings obtained in the light of scientific rigor of the profound relationships between the geological/geochemical environment and the

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health of populations, the from the effect of the chemical element fluorine, whose omnipresence is remarkable in modern society.

2 - SITES OF JUSSIAPE

The Municipality of Jussiape is located in the planning region of Chapada Diamantina in the State of Bahia, limited to the East by the Municipalities of Ibicoara and Barra da Estiva, to the south by Ituaçu, to the west by Rio de Contas, and to the north by Abaíra and Mucugê. The municipal area is 562 km². (Figure 2). In terms of regional geology, the municipality is inserted in lithotypes representing the Paraguaçu group and the Gavião CPRM Complex, (2005).

Figure 2 – Location of the municipality of Jussiape (source Nunes, 2006).

According to Cruz et al., (2011) the geological sites in the municipality of Jussiape, within the domains of the Gavião Block, represent the domains of the Jussiape suite, which is formed by monzogranites to syenogranites, mylonitized or not, hololeucocratic to leucocratic, of pinkish colour of medium granite, non-isotropic, equigranulares with textures dominated by alkaline feldspar phenocrysts, rich in apatite, characterized by Nunes (2006) as fluorapatites. From a lithogeochemical point of view, granitoids have a peraluminous, calcium-alkaline, high-potassium character.

Based on studies by CPRM, (2005), it is assumed that the suite of rocks described in the epigraph contains a fractured rocks aquifer, where there is basically no primary porosity, the occurrence of groundwater is conditioned by a secondary porosity represented by fractures and cracks, which translates into random, discontinuous and small reservoirs, within this context, in general, the flows produced by wells are small and the water, due to the lack of circulation, the effects of the semi-arid climate and the type of rock, it is most often salinized.

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These conditions define a low hydrogeological potential for the rocks, without, however, diminishing their importance as an alternative supply in the cases of the small community of Cruz, as a strategic reserve in periods of prolonged drought, thus motivating drilling. of wells for groundwater that supplies the community.

The composition of Jussiape's groundwater, plotted on the Pi-per Diagram (1944) for hydro-chemical classification (Figure 3) and indicates potability in relation to fluoride according to Ordinance MS 888/21 (Brazil, 2021).

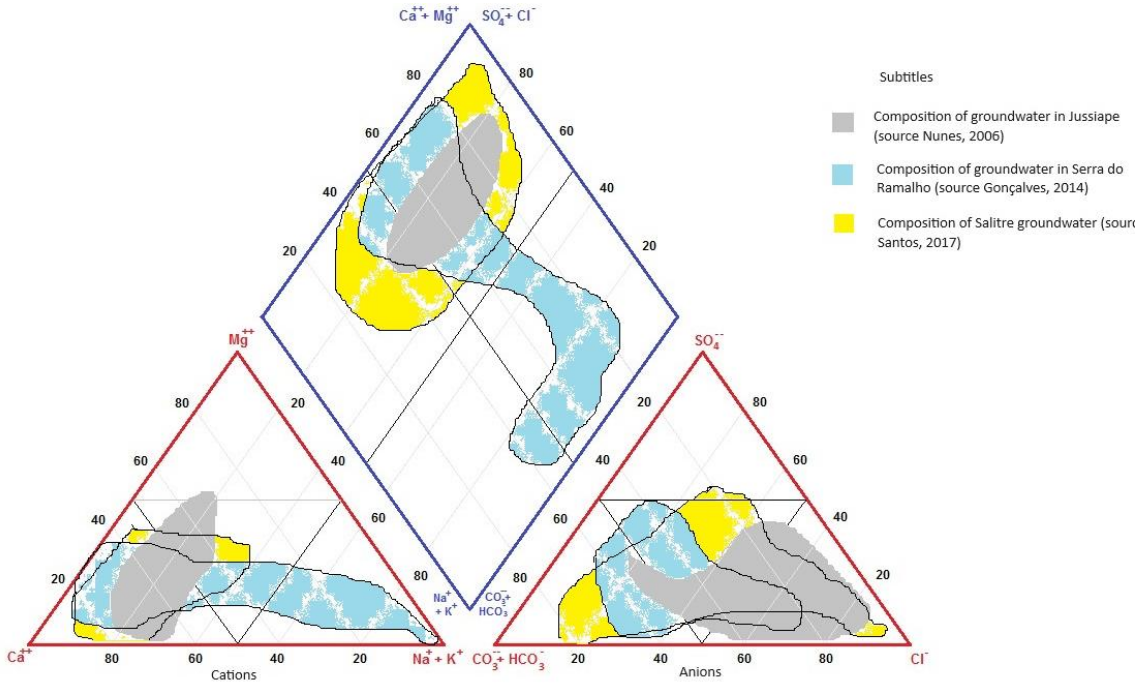

Figure 3 - The composition groundwater, plotted on Piper's diagram (1944) for hydro-chemical classification (Nunes, 2006)

It is observed that the waters are predominantly classified as sulphated (Nunes, 2006).

The F content in these groundwater samples presents a striking distinction between water from groundwater wells drilled in orthogneisse-type rocks of the Jussiape suite, where the content reaches levels many times higher than F>0.8 mg/L in contracts with other wells, where values are lower than F<0.8 mg/L (Nunes,2006)

Based on these values, the first principles Galagan & Vermillion (1957) were applied, whose optimal fluoride content (C) in water is a function of the average regional air

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temperature (T), obtaining the values, taking into account local drinking restrictions, in accordance with Ordinance 888/21, W.H.O. (2006), presented in Figure 4. It is observed that 73 of the samples exceed the optimal limit of Ordinance 88/2021 (Brazil, 2021) or W.H.O (2006).

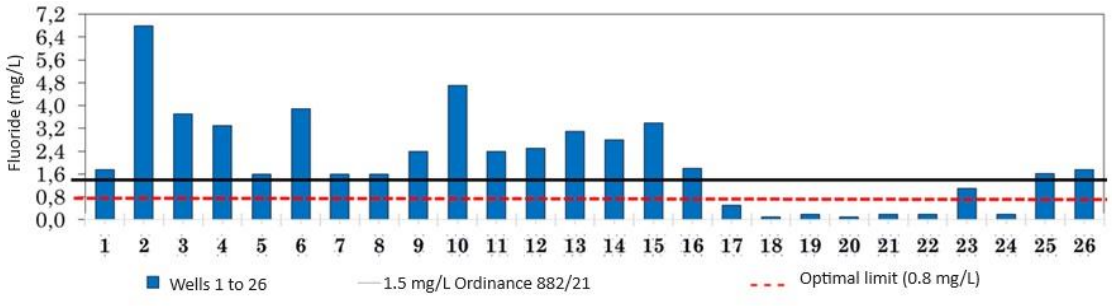

Figure 4 – Optimal levels of fluoride content in Jussiape groundwater.

For comparison purposes, existing fluoride data from municipalities neighbouring Jussiape, obtained from the SIAGAS database, was used, creating the histogram presented in Figure 5.

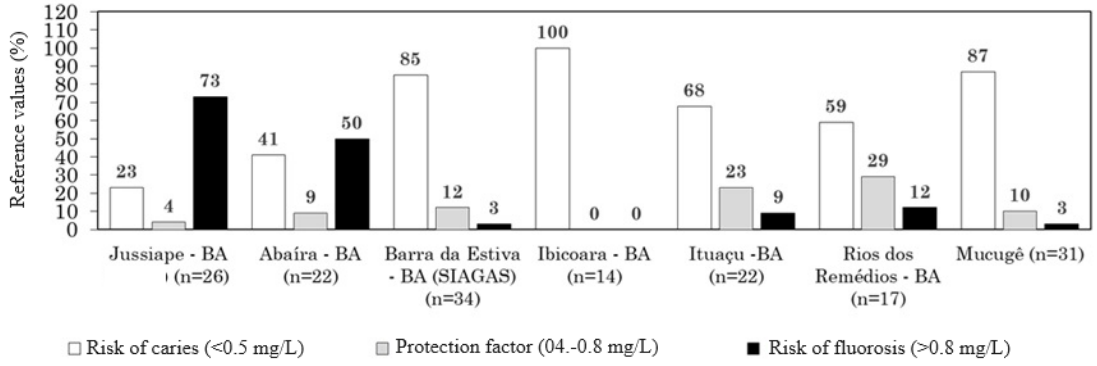

Figure 5 – Comparison of risk of dental fluorosis between Jussiape and neighbouring municipalities.

It is observed (Figure 5), that the risk of dental fluorosis in the municipality of Jussiape reaches a figure of around 73% of the reference values. Explaining, in this way, that the findings of dental fluorosis of the prosthetist Mr. Nelson Pereira Nunes, would be directly related to the high levels of fluoride present in the groundwater coming from the pumped wells in the town of Cruz and distributed to the population.

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Bearing in mind that these groundwaters came from the fissure aquifer installed in the granitoid rocks rich in fluorapatites, with a probable high residence rate and low feedback value, there is a great possibility that the fluorine element present is the product of dissolution. of this phosphate mineral due to weathering factors (Nunes and Cruz, 2007).

On the other hand, comparison of the risk of dental fluorosis in neighbouring municipalities as Abaíra, Barra da Estiva, Ituaçu, Rios dos Remédios and Mucugê indicate that in the municipality of Abaíra a high-risk number, reaching reference values in the order of 50 %, indicating the need to assess the population's oral health. (Gonçalves et al.,2022)

It is observed that, in the vicinity of the municipality of Rio dos Remédios, the reference values reach around 12%. However, the geology of this location is characterized by manifestations of volcanic rocks of an alkaline nature, which raises the need to develop new studies that characterize the composition of groundwater coming from wells drilled in these lithologies.

3 - SITES OF SERRA DO RAMALHO

In the Serra do Ramalho region, south west of the State of Bahia (Figure 6), Neoproterozoic pelitic-carbonate rocks of the Bambuí Group emerged, overlying the predominantly Archean-Paleoproterozoic migmatite gneiss crystalline basement (Misi et al. 2011). The main rocks in the region are limestones and dolomites from the Sete Lagoas Formation, the base of the Bambuí Group that houses the karst-fractured aquifer. This lithic group is covered by detrital sediments and placers of third-quaternary age. Hosted in carbonate rocks, there are fluorite mineralization described as being of epigenetic origin from the circulation of hydrothermal fluids in zones of greater porosity and permeability controlled by paleo-geography and with diagenetic concentration (Dardenne et al. 1998, Costa, 2011). This region is part of the domains of the mega hydrofluoric province of Brazil de Silva et al. (2020)

The surface waters of the Serra do Ramalho region involve the network of watercourses that drain directly into the São Francisco River channel. They involve a multitude of small intermittent streams, whose flows are directly related to rainfall, remaining dry for several months (Gonçalves et al., 2019). Its main river is the Corrente, which has a perennial character and is known for the excellent quality of its waters, suitable for the most diverse uses.

The integrated water supply system was implemented in 2008 by EMBASA - Empresa Baiana de Água e Saneamento, which collects water from the Corrente river, complementing the supply to populations, with the use of groundwater, pumped from several wells. tubulars, especially in times of low rainfall. The town of Santana-Ba is

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supplied solely by the network of underground water wells, and does not yet receive water collected by surface rivers Coutinho, (2014).

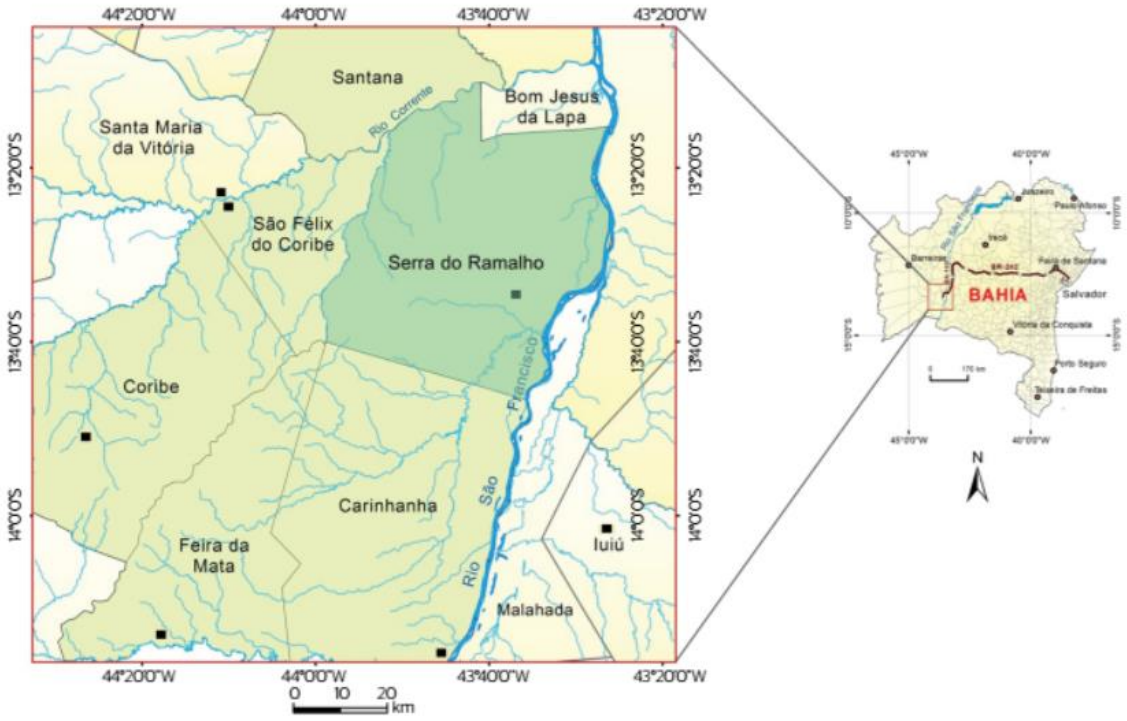

Figure 6 – Location of the Serra do Ramalho region (source Gonçalves et al,2018)

The classification of groundwater related to fluorine content is presented in Figure 3, diagram by Pyper, (1946), predominating calcium/magnesian and mixed waters, where fluorine values often present values greater than 0, 8 mg/L.

The Santana sites, in the Serra do Ramalho region, have a semi-arid tropical climate with sub-humid climate characteristics (Koopen, 1936), presenting moderate temperatures of 25º C to 26º C. The average annual precipitation in the region is of 1,099.8 mm/year with the rainy and dry seasons. Two seasons can be characterized, well defined in terms of rainfall in the region: a rainy season (90% of the total rainfall in the year), which runs from October to April, and another dry season (10% of the total rainfall in the year), which runs from May to September. The months of November, December and January are those with the highest rainfall when thunderstorms occur (SEI, 1999).

The distribution of fluor levels in the Serra do Ramalho region, taking into account the dry and rainy periods, is shown in Figure 7. It can be seen that the town of Santana is located in the region with the highest levels of flour, reaching values of around 5.8 mg/L F (Gonçalves, 2014).

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The enrichment of fluorine in groundwater in the Serra do Ramalho region was deeply researched by Gonçalves, (2014), who interpreted the existence of high levels of fluorine through the enrichment relationship of this element through the action of bicarbonate, as attributed by Handa, 1975; Rao, 2011; Vikas et al., 2013, according to the reaction:

$CaCO + 2F^- + H^+ \leftrightarrow CaF_2 + HCO_3^-$

$K\ CaF2 \leftrightarrow CaCO_3 = a(HCO_3^-) / a(H^+). (F^-)^2$

And the presence of sodium content in the solution favours the dissociation of fluorite (Apambire et al., 1997; Saxena; Ahemed, 2003; Rao, 2011).

$CaF_2 + Na_2CO_3 \leftrightarrow CaCO_3 + 2F^- + 2Na^+$

$CaF_2 + 2NaHCO_3 \leftrightarrow CaCO_3 + 2\ Na^+ + 2F^- + H_2O + CO_2$

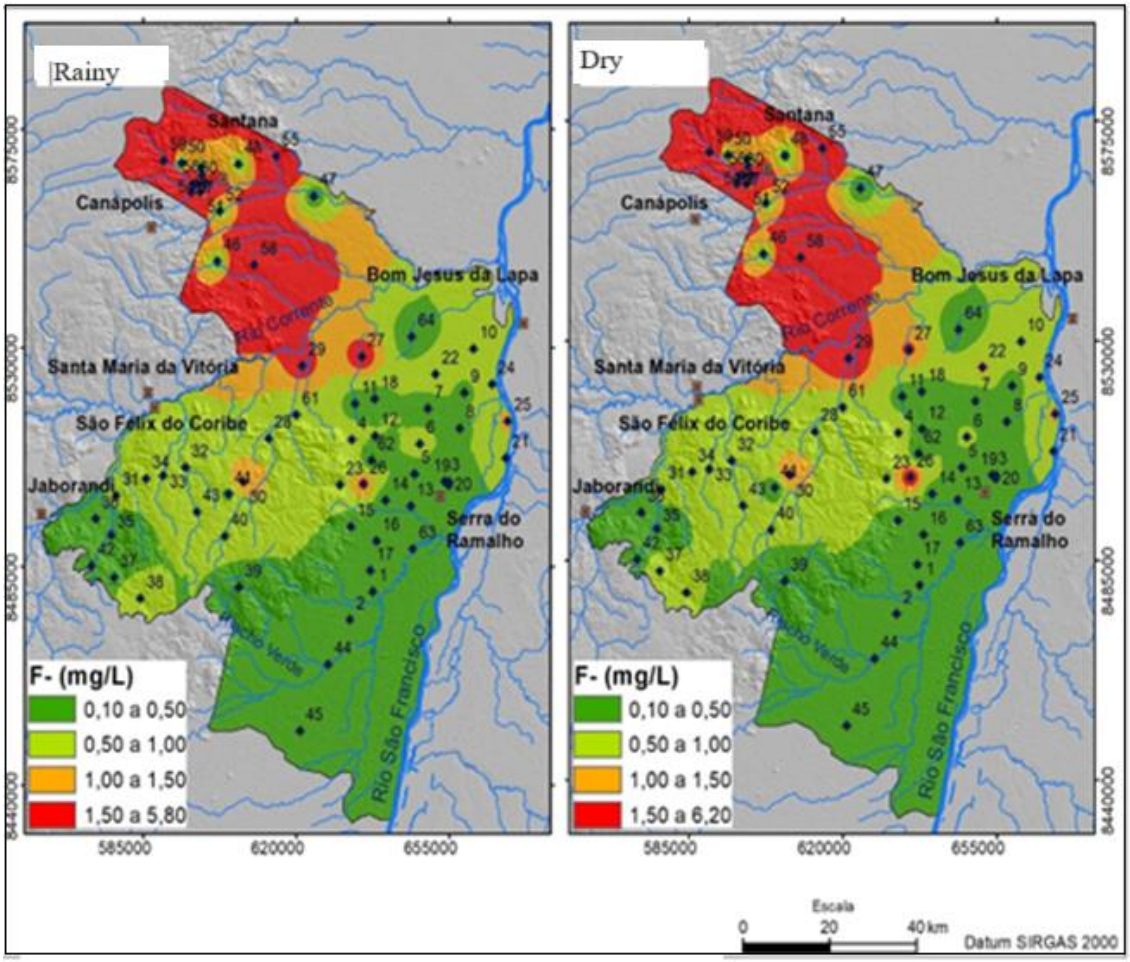

Figure 7 – Distribution of fluoride levels in the Serra do Ramalho region, during the rainy and dry seasons (source, Gonçalves,2014)

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The study and characterization of dental fluorosis was created by Coutinho, (2014) based on hydrogeological data and interpretations by Gonçalves (2014), initially summarized by Cruz et al, (2015). This research was carried out in the municipality of Santana-BA, in western Bahia.

In view of reports from employees of the Municipal Health Department of Santana about the probable existence of dental fluorosis in the locality, it was created by Coutinho, (who, in addition to his training as a geologist, has a Dental Surgeon diploma issued by the School of Dentistry of Santana, Federal University of Bahia), a study exploratory research that, in addition to local geological, physiographic, socio-economic, hydro-chemical and epidemiological bibliographical surveys, a sampling design was drawn up with the aim of obtaining the prevalence and severity of fluorosis in Santana, involving students aged 12 years. The study was registered with the ethics committee through the Brasil platform website (Ministry of Health).

It is important to point out that all steps relating to clinical analyses to assess the prevalence and severity of dental fluorosis were previously informed to students and guardians through the informed consent form.

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It is important to point out that all steps relating to clinical analyses to assess the prevalence and severity of dental fluorosis were previously informed to students and guardians through the informed consent form. An important photographic document of dental studies on dental fluorosis is found in Coutinho (2014).

Based on the levels of chemical elements present in the waters of Santana, plus on-site studies of dental aspects of dental fluorosis, which was deeply characterized and verified by Coutinho, the principles Galagan & Vermillion (1957) were applied, with the same

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methodology applied in the Jussiape region, described above. Using the optimal fluoride levels (C) in the water as a function of the regional average air temperature (T). The results are presented in Table 2. It can be seen that the prevalence of dental fluorosis is around 53%, with 17% characterized as moderate or severe.

Table 2 - Frequency and categories indicated by the Dean Index (1934) in 12-year-old students in Santana (source Coutinho, 2014).

Dental Fluorosis	Male		Female			
Absence	N	%	N	%	N	%
Contestable	35	22	38	24	79	46
Very light	4	2,5	5	3	9	5,5
Light	11	7	17	11	28	18
Moderate	5	3	10	6	12	7,5
Severe	4	2,5	8	5	12	7,5
Light	64	40	95	60	159	100

Based on these studies carried out, it became clear the importance of implementing the SUS – Unified Health System, several USF – Family Health Unit of Brazil, through the oral health group, uses the topical application of fluoride in collective action carried out in schools in communities within the USF area. However, it is understood that this necessary practice requires important regionalization and local observations since the generic action of fluoride can be a precursor to the worsening of dental fluorosis, in addition to causing waste of public money with the acquisition of topical fluoride, used on a high scale.

It is important to point out that geogenic fluoride from existing natural sources and available in water may be close to those used in fluoridated topical gels sold on the dental

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market. Based on the data presented, it is concluded that there is a need for better government management.

4 - IRECÊ SITES

Research related to the behaviour of fluorine in the regions of Jussiape and Serra do Ramalho has highlighted the need to extend research to other regions of the state of Bahia, especially in geological sites where carbonate sedimentary rocks dominate, characterized as the Irecê Sedimentary Basin (BSI). Research projects were developed that resulted in two doctoral theses Santos (2017) and Cunha, (2014) and a master's thesis created by Gasser, (2019).

The Irecê Basin (Figure 8) is inserted in the geological panorama of the central portion of the State of Bahia. It is a triangular-shaped sedimentary basin filled with sediments belonging to the Una Group, which is represented from base to top by glaciogenic deposits of the Bebedouro Formation and a predominantly carbonate, non-metamorphosed sequence of the Salitre Formation. According to Souza et al. (1993), the Salitre Formation consists of carbonatic and siliciclastic lithofacies, which were deposited in a shallow marine environment and tidal plain, limited by gradational and interdigitated contacts.

Salles, (2017) described Salitre as a Proterozoic karst aquifer that makes up an important speleological site in the country. The same author refers to the aquifer as an important reservoir of groundwater and a valuable resource in the water supply of the rural population. Karst hydrogeology is characterized by a network of interconnected fissures, fractures and conduits placed in a rock matrix of relatively low permeability. Most groundwater flow and transport occur through the network of openings, while most groundwater storage occurs in the matrix.

As the Salitre region was not affected by an important geodynamic event, karstification tends to gradually lose its intensity whatever the climate and fissured context. The karst system is then more or less completely fossilized and can remain inactive for long periods, thus allowing research into the evolution of the chemical composition of stored waters to have a real composition of the chemical composition obtained by hydrogeochemical modelling.

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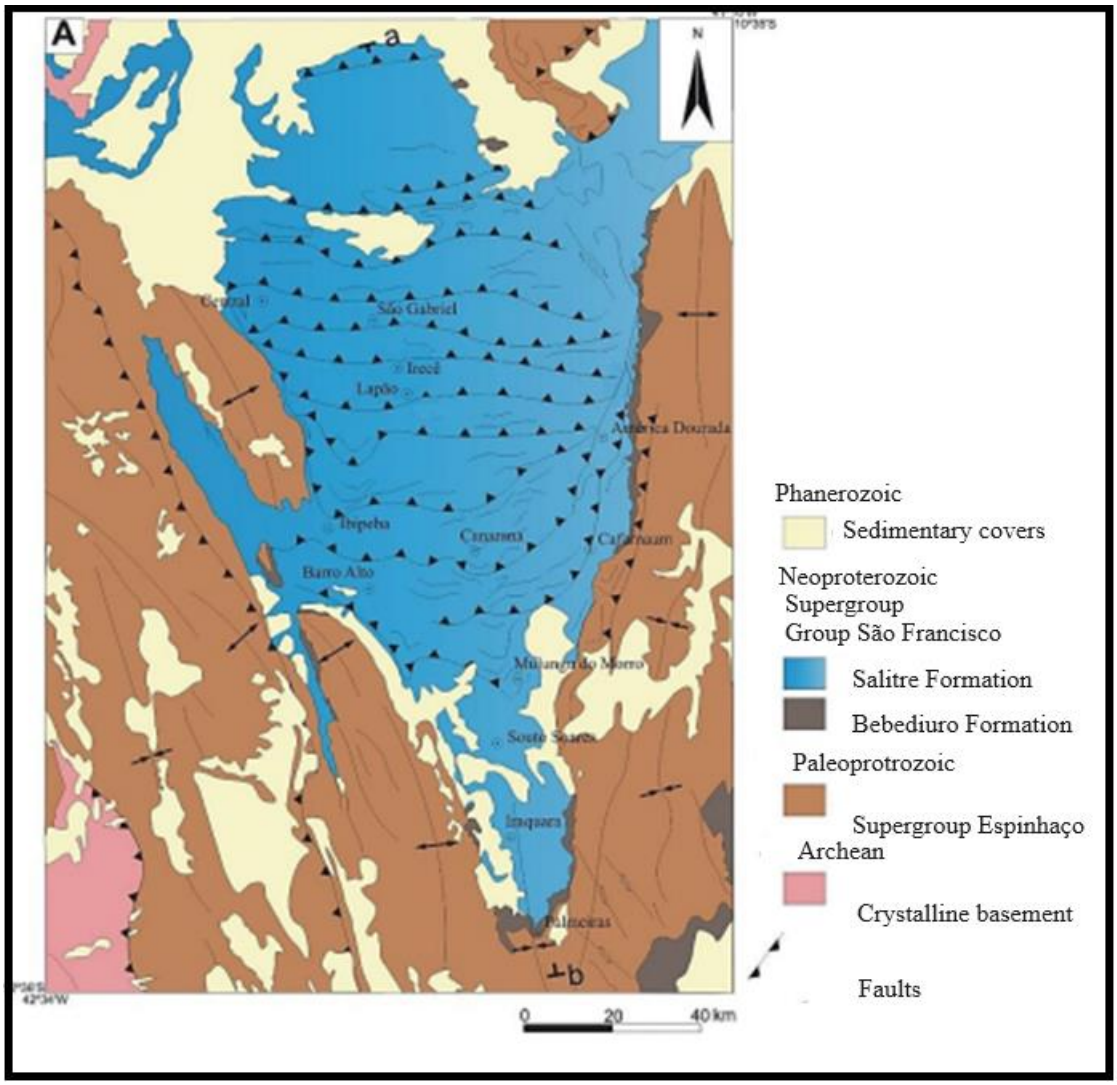

Figure 8 – Simplified geology of Irecê sedimentary basin (ISB), apud Santos, 2017).

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thus allowing research into the evolution of the chemical composition of stored waters to have a real composition of the chemical composition obtained by hydrogeochemical modelling.

Mineralization of barite and sulphides of Fe, Zn, Pb and Cu are described in the Salitre formation (Souza et al., 1993; CPRM, 1999; Misi et al., 2000; Misi et al., 2004, Misi et al., 2005). The detailed study of laboratory modelling between groundwater and the carbonate rocks that constitute the aquifer was developed by Cunha (2018) and published by Cunha et al., (2022), Gonçalves et al., (2022).

In the southern portion of the BSI, four quarries informally named (M), Melancias, (S), Segredo (SJ), São José and (P) Palmeiras in Cunha (2018) were selected. Around 0.4m3 (around 100 kg) of rock were collected at these sites, which was broken, quartered and multiple samples sent for different analytical procedures. The samples intended for mineralogical and petrographic studies were reduced to the size of a hand sample, described with the naked eye, subjected to macroscopic study under a binocular magnifying glass, thin and polished sections were made for study under a refracted and reflected light microscope and analysed punctually under the microscope. scanning electronics with energy dispersive spectroscopy (MEV/EDS), Tescan brand, model Vega 3. The point chemical data of the minerals were obtained by an EDS, coupled to the SEM, brand Oxford Instruments®, model X-Act and SDD detector (Silicon Drift Detector), with a resolution of 125 eV. The analytical conditions were: potential acceleration (voltage) of 15 kV and current varying from 10 to 20 mA, which generated an electron beam with a diameter between 290 and 830 nm. These procedures were created at the Microanalysis Laboratory of the Condominium of Multi-User Geosciences Laboratories (CLGeo) of the Federal University of Sergipe.

The main mineralogical crystalline phases of the samples were identified using the X-ray Diffraction Spectroscopy technique and quantified using the Rietveld method (RIETVELD, 1967). To this end, a Bruker D2 Phaser diffractometer was used, with a 30 kV and 10 mA copper target tube, with a wavelength (λ) equal to 0.15406 nm, without a filtering system, with a secondary monochromator. Diffraction spectra were obtained in the 2θ range from 5° to 90°, continuous mode, at 0.0165º/s (1º/min). The phases present in the samples were identified with the help of the DIFFRAC plus-EVA computer program, based on the COD system (Crystallography Open Database) and quantified with the help of the TOPAS software, which is based on the Rietveld method (1967), using from CIF (Crystallography Information File) system files. These analyses were developed at the Material Durability Testing Laboratory – LEDMa, at the Polytechnic School of the Federal University of Bahia.

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After detailed petrographic characterization, the samples were subjected to two types of tests called i) closed reactor test and ii) leaching column test. The detailed results of these applied methodologies, results and conclusions were published by Cunha et al., (2022), Gonçalves et al, (2022). The laboratory data were compared by experimental analytical results, obtained from well sampling published by Gasser (2017) Salles, (2017) and Santos (2017). Numerical comparisons of the results published by the authors op cit show that:

A - Comparison of laboratory modelling results generated by Cunha, (2018), Cunha et al. (2022), Gonçalves at al. (2022) with field data from Gasser, (2017), Salles, (2017) and Santos (2017) through the application of multivariate statistical analysis Gonçalves at al. (2022) and application of the Mann-Whitney test, and more effective when the tubular wells are closer to the site where the rock samples were collected, thus confirming the veracity of the applied modelling.

B - Thus, as limestone rock is poorly soluble in pure water, as the dissolution of calcite and aragonite are not spontaneous, the presence of sinkholes can be explained by the increase in the solubility of limestone rock, which is increased due to the formation of sulfuric acid (sulphide oxidation) and carbonic acid, generated by the absorption of CO2 (atmospheric and biochemical) by meteoric water) Cunha, (2018),

C - Observations from the Serra do Ramalho sites were confirmed, where the presence of fluoride is associated with an increase in pH, EC and Na_2CO_3 parameters, with the same reactions existing for the release and enrichment of fluoride in groundwater, where the presence of Sodium content F the release of fluorite, as found by Apambira et al (1997), Saxena and Ahemed, (2023) and Rao, (2011). These findings make it possible to use the same criteria applied at the Jussiape and Serra do Ramalho sites, for comparisons of restrictions on the potability of groundwater taking into account the high levels of fluoride. Figure 3 shows the domains of the ISB classification of groundwater relating them to fluoride levels.

Thus, the relationship between fluorine and nitrogen can be applied in the sense of the same local potability restrictions, in accordance with Ordinance 888/21, or W.H.O. (2006) (Figure 9) and establish the same risk factors for the oral health of populations (Figure 10)

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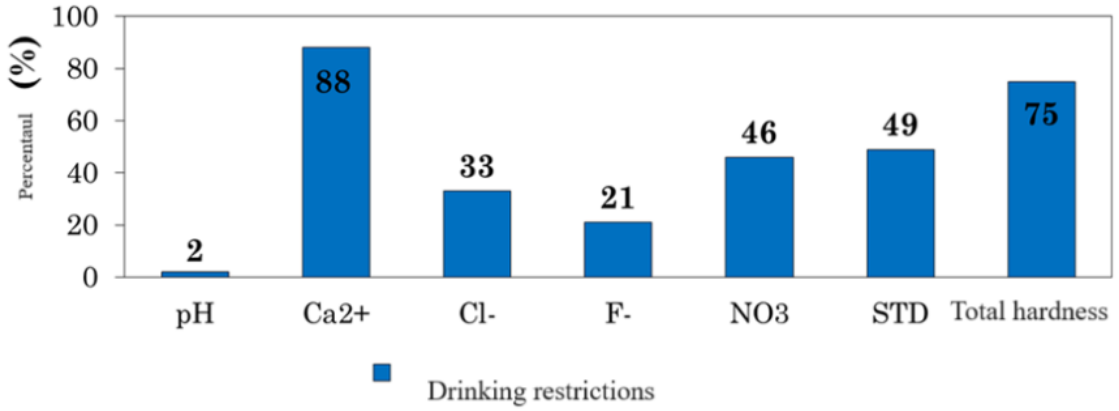

Figure 9- BSI groundwater potability restrictions.

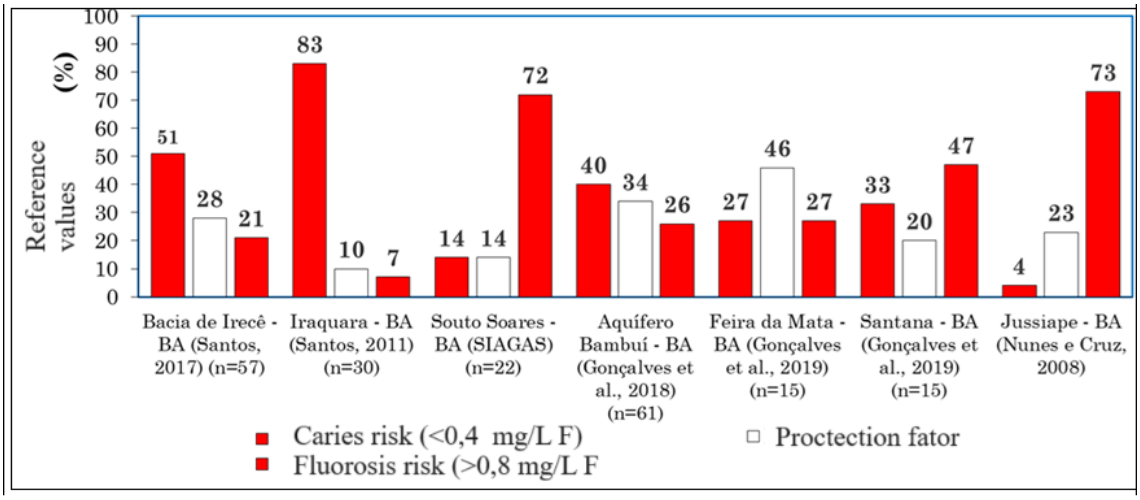

Figure 10 - Fluoride levels in groundwater and oral health risk categories.

The data shows that the risks to oral health, in comparison with the sites of Jussiape, Santana, Feira da Mata and the Bambuí aquifer (Nunes and Cruz, 2008, Gonçalves et al 2018, Gonçalves et al 2019,) data from Santos, 2011 and Santos, 2017) (Figure 10) present a high risk of dental fluorosis for the population, reaching numbers of around 73% of the reference values.

5 - LAURO DE FREITAS SITES

Oliveira, (2014), presented important results on dental fluorosis in the municipality of Lauro de Freitas (Figure 11) oral health professionals verified, in certain diseases, among other diseases, the important manifestation of dental fluorosis in a significant portion of students at the level medium of the public network, raising alarm to health agencies, becoming the target of concern and study by health professionals in the municipality

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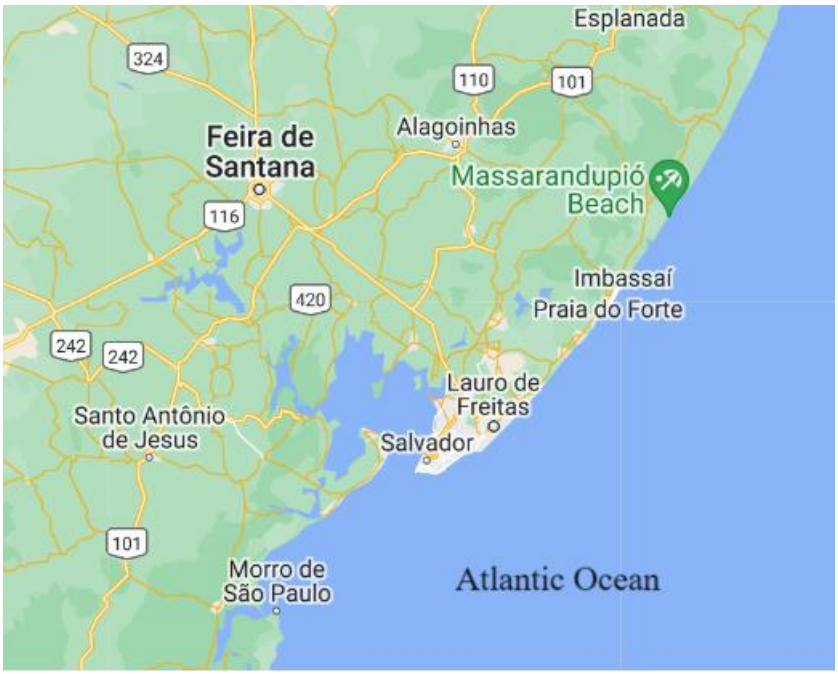

Figure 11 - Location of the municipality of Lauro de Freitas (source Oliveira, 2014).

The local geology is represented by rocks from the Crystalline Complex, Barreiras Formation (Pliocene) and the Quaternary Deposits, (Nascimento and Barbosa, 2005). In this context, soils of the dystrophic red-yellowish latosol, yellowish-red podzolic, with a predominance of marine quartz sands. The primary sources used to supply the municipality of Lauro de Freitas correspond to the Pedra do Cavalo and Joanes II Dams, inserted, respectively, in the Hydrographic Basins of the Paraguaçu and Joanes rivers. The water distributed by EMBASA receives conventional treatment and fluoridation.

The municipality's water supply is mainly carried out by the supply of surface water treated by EMBASA, a state sanitation company, which serves the majority of the population and, in a complementary way, by underground water collection wells. There are no official data regarding the percentages of the population supplied by these two main sources, however, despite the majority being supplied by water supplied by Embasa, a total of 23 underground collection wells were opened by the State Government whose partial chemical data or Totals are available in the SIAGAS register - Groundwater Information System of the National Geological Service, (CPRM), (Figure 12). A series of other wells that supply considerable portions of the population, opened by individuals, private companies and condominiums, as they do not have records or records of data on chemical analysis of the water.

The F ion values in the water from the Lauro de Freitas wells ranged from 0.09 to 2.93 mg/L, with a median equal to 0.65 mg/L and a non-normal distribution, according to Oliveira, (2014). In several wells, the levels exceeded the maximum permitted limit, of

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1.5 mg/L, of Ordinance no. 2,914/2011 (MS) and the WHO (1993), which drew attention to Oliveira, (2014).

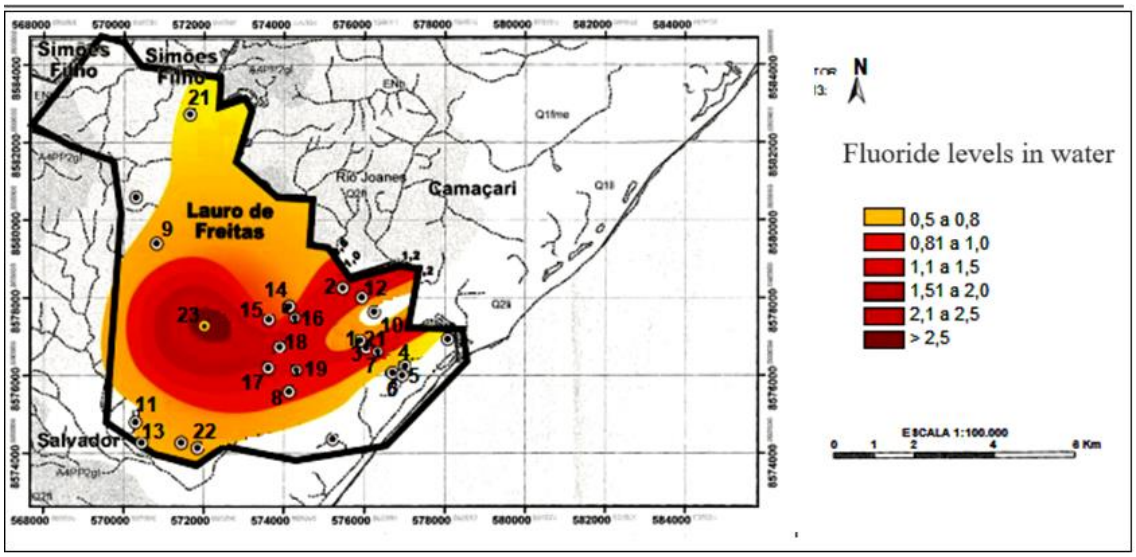

Figure 12 - Distribution of fluoride levels in groundwater in the municipality of Lauro de Freitas, Bahia (source Oliveira, 2014)

Using the same comparative standards between the different sites previously mentioned in this article, the data can be observed in Figure 13, where the percentage of reference values for the locations of Lauro de Freitas is observed (Oliveira, 2014, Oliveira et al 2022), Serra do Ramalho, Feira da Mata, Santana de Gonçalves et al., (2019) and Jussiape de Nunes and Cruz, (2006), where dental fluorosis presents lower rates than in the other compared sites.

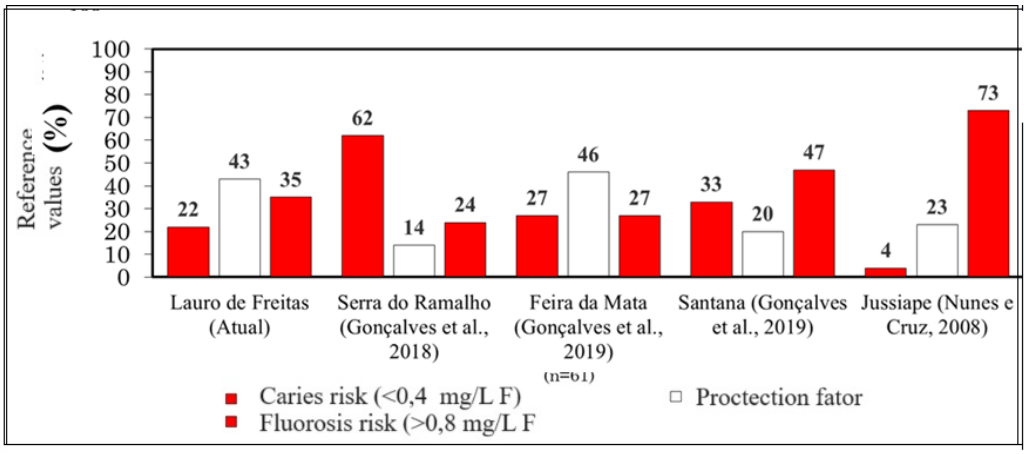

Figure 13 – Risks of dental fluorosis in the sites surveyed.

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5 - CONCLUSIONS

In the 1990s, several epidemiological studies were carried out around the world describing differences in the prevalence of fluorosis, ranging from the almost absence of the disease in populations of less than 2.2%, to proportions greater than 90% (Akpata et al., 1997; Downer, 1994). In Brazil, similarly, studies describe prevalence rates ranging from zero (Campos et. al., 1998) to 97.6% (Capella et. al., 1998). Cangussu et. al, (2002), states that even in places with high prevalence, the proportion of individuals who present the moderate and severe forms is still small, only increasing significantly in places where fluorosis is due to the high concentration of fluoride in natural water sources, as are all the sites presented in this article.

The results of the research presented highlight the importance of the emerging science of Medical Geology, where the action of geological and geogenic materials on human health in populations of sites in the State of Bahia is proven.

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