GEOGRAPHICAL-GEOCHEMICAL PECULIARITIES OF FLUORINE SPREAD IN NATURAL COMPONENTS OF ODESSA REGION AND ITS IMPACT ON SOME DENTAL DISEASES OF THE POPULATION

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Rezumat

În premieră pentru teritoriul Regiunii Odessa a fost efectuat studiul sistematic al migrării şi acumulării fluorului în componentele naturale: soluri, roci parentale, apele subterane şi de suprafaţă. Au fost identificate teritoriile cu conţinutul sporit şi scăzut de fluor în soluri şi ape de suprafaţă şi subterane, inclusiv potabile. Au fost evidenţiate zonele industriale ale oraşului Odessa, caracterizate cu conţinutul majorat de fluor în sol şi plante. A fost stabilită dependenţa unor afecţiuni dentare ale populaţiei Regiunii Odessa de conţinutul fluorului în apă potabilă.

Cuvinte cheie: Fluor, soluri, roci parentale, apele subterane şi de suprafaţă, afecţiuni dentare.

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Introduction

Still in the ancient times the founder of modern medicine Hippocrates wrote about impact of natural factors on people. Both physicians and other scientists have pointed to the connection of human health and the environment.

Unfavourable factors of the environment, conditioned by human economical activity have negative impact on the state of the population health. Long-lasting pollution of water, air, soils with high doses of elements of I and II classes of danger, consumption

of "contaminated" products and water produce substantial impact on all organs and systems of the organism, especially on the child's organism. Fluorine belongs to such elements. It differs from other chemical elements by extremely high reactive ability: fluorine reacts with nearly all elements, except helium, neon and argon.

For fluorine geochemistry low solubility of CaF_2 ($2.1\ 10^3$ %) is very important, which determines possibility of its sedimentation on calcium barrier. According to the studies by A.I.Perelman, fluorine migration in arid landscapes is considered, first of all, with taking into account fluorine sedimentation by carbonates of soils and rocks, which reduces possibility of conglomeration of mobile forms in soil profile and ground waters [6, 7].

Fluorine belongs to the group of biologically active and vital for people microelements. Its shortage or excess in human organism (because of low or high content of the element in components of the natural environment and food products) conditions development of endemic diseases – endemic fluorosis of teeth and bones, osteosclerosis, nervous diseases, caries disease in the population, metabolic disorders in the organism, impairment of kidney functioning, acceleration of the organism aging, etc. Dental diseases are manifested in the most acute way.

Research methodology

The object of our research is fluorine in the interrelated system "natural environment – human being". The aim of the research is to identify peculiarities of fluorine distribution in natural components of Odessa region and Odessa city and its impact on caries and fluorosis disease in the population.

Studied were: content of fluorine in soils, soil-forming rocks, ground, surface (including drinking) and sewage waters of Odessa region and connection of fluorine content in natural components with the level of affection of teeth in residents of different districts of Odessa region with caries and fluorosis.

Content of fluorine in natural components was determined by potentiometric method with application of fluorine-selective electrode of EF-IV type.

In order to determine impact of fluorine on dental status of the population of Odessa region fund materials of Institute of Dentistry, Academy of Medical Sciences of Ukraine, as to the incidence of dental caries and fluorosis in the population were used.

Results and discussion

Peculiarities of fluorine accumulation in natural components of Odessa region are conditioned by regional and geographical-geochemical peculiarities. Content of fluorine in soils varies within the limits of: gross – 131.0-670.0 mg/kg, water-soluble – 0.70-6.73 mg/kg, which is caused by differences of granulometric composition, content of humus, carbonates, easily soluble salts and ameliorative state of soils. Natural increase of fluorine content in upper horizons of soils from eluvial to transeluvial (slopes) and accumulative (floodplains of rivers, bottoms of gullies) landscapes from 1.0 to 7.0 mg/kg was determined, which testifies to high migration activity of fluorine. Vertical differentiation of chernozems and forest thickness by fluorine content is determined first of all by peculiarities of their granulometric composition and character of distribution of easily dissolved salts and carbonates of calcium. Maximal values of gross fluorine content in illuvial-carbonate horizons reaches the value 1000 mg/kg, that of water-

soluble fluorine being 30 mg/kg. Content of fluorine in plants depends on its content in soils: increase of content of water-soluble fluorine in soils causes increase of its quantity in plants and ground waters [8].

Presence of technologically polluted with fluorine soils in Odessa city is connected with presence of emissions of industrial enterprises and automobile transport. Technogenic pollution is manifested by accumulation of gross and especially water-soluble fluorine forms. Maximal degree of pollution of the city soils is 50 times higher in comparison with the background one. Character of agricultural use also has great impact on the degree of soil pollution with water-soluble fluorine.

Natural waters are one of main sources of fluorine supply into human organism. Chemical composition of natural waters is formed under impact of numerous natural factors (climate, chemical composition of water-containing rocks, tectonics, water circulation, etc.), which conditions their hydrochemical zonality – horizontal (plane) and vertical (depth). Human technogenic activity has significant, mainly, negative, impact of water composition.

Water resources of Odessa region are composed of supplies of underground and surface waters. Supplies of surface waters on the region territory are distributed in non-uniform way. South West, which tends to the Dniester and Danube rivers is the most provided, the Southern and central part of the territory are characterised by limited water supplies. Provision of need with ground waters of drinking quality on the whole for the region constitutes 28%. Nearly 72% of drinking water supply of the region is provided at the expense of land sources. The following water supply networks obtain water from land sources: Odessa water supply network obtains water from the Dniester River, Kiliiska and Vylkivska – from the Danube River, Bolgradska – from Yalpug Lake. All other centres of population use water mainly from ground sources [9].

Mineralisation, chemical composition and in particular content of fluorine in underground and soil-undersoil waters of the research territory are formed mainly at the expense of their transit from Ukrainian Crystalline Shield and Podilska Upland. Ground waters are characterised by different values of fluorine content (0.21-2.91 mg/l), which in some cases are higher than threshold limit values. Waters which are proximate to aquifers of forest formation are characterized by lower values of fluorine content, (0.16-0.80 mg/l), with higher values of fluorine content being observed in aquifers, proximate to low Quaternary and upper Pliocene deposits (1.6-2.09 mg/l) [10].

Main sources of fluorine supply to surface waters are fluorine-containing mineral fertilisers, chemical ameliorating agents, and sewage waters. Analysis of literature sources with regard to fluorine content in surface waters of the studied territory proved that such data are rare. According with the research by R.D. Gabovich, fluorine content in the Dniester water is within 0.09-0.21 mg/l, Southern Bug – 0.17-0.30 mg/l, Danube – 0.10-0.25 mg/l) [1]. In accordance with our data content of fluorine in surface waters of Odessa region varies within the wide range – from 0.17 mg/l to 1.22 mg/l (Table 1).

The results of determination of fluorine content in surface waters of the studies territory for the last decade showed the tendency of its increase in waters of the rivers Danube, Dniester, Southern Bug and small rivers of Zadnistrovie [10].

Table 1. Content of fluorine in surface waters of Odessa region (mg/l)

Object of sampling	Content of fluorine	Object of sampling	Content of fluorine
Danube River	0.20 - 0.59	Southern Bug River	0.17 - 0.43
Dniester River	0.24 - 0.27	Sasyk Lake	0.34 - 0.60
Kohilnik River	0.34 - 1.22	Kitai Lake	0.37 - 0.56
Sarata River	0.40 - 0.70	Yalpug Lake	0.48 - 0.61

One of essential reasons of pollution of water basins, which results in decrease of quality of natural surface waters lies in discharge of economical-household and industrial sewage waters. Thus, only over a year enterprises, organisations and institutions of Odessa region discharged 321 mln cubic meters of sewage waters into surface water basins, with nearly half of them being discharged without or with insufficient purification. Content of fluorine in sewage waters of Odessa city enterprises varies from 0.11 mg/l to 1.35 mg/l, in many cases exceeding TLV [10].

One of the most important factors, which determine individual and population heath of the population, is water [2-4]. When studying quality of drinking water, in addition to determination of components, it is necessary to take into account absence or insufficient quantity of a number of biologically active components, presence of which in the environmental waters and in internal environments of organisms plays important role in regulation of processes of people's vital activity [4, 8]. Fluorine relates to such microelements.

Research on fluorine content in drinking waters of Odessa region is presented in Table 2. With considerable variability of fluorine content in drinking waters of the region, zones of its higher content, which include Artsizkyi – 1.92 mg/l (in some samples content of fluorine reached 5 mg/l), Tarutynskyi – 1.84 mg/l (in some samples – up to 3.8 mg/l) and Tatarbunarskyi districts – 1.48 mg/l. In most districts of the region content of fluorine in drinking waters does not exceed 0.5 mg/l, which testifies to higher risk of affection of dental enamel with caries and requires application of corresponding preventing measures. Drinking waters of Rozdilnianskyi, Biliaivskyi, Savranskyi districts and Odessa city have the lowest content of fluorine (0.12-0.23 mg/l) [11].

Table 2. Content of fluorine in drinking waters of Odessa region

District	Fluorine, mg/l	District	Fluorine, mg/l	District	Fluorine, mg/l
Ananivskyi	0.48	Izmailskyi	0.65	Rozdilnianskyi	0.20
Artsyzskyi	1.92	Kiliiskyi	0.28	Reniiskyi	0.32
Baltskyi	0.45	Kodymskyi	0.28	Savranskyi	0.23
Biliaivskyi	0.21	Kominternivskyi	0.47	Saratskyi	1.15
Berezivskyi	0.44	Kotovskyi	0.58	Tarutinskyi	1.84
Bolgradskyi	0.51	Krasnooknianskyi	0.65	Tatarbunarskyi	1.48
B.Dnistrovskyi	0.73	Liubashivskyi	0.60	Frunzivskyi	0.53
V.Mykhailivskyi	0.42	Mykolaivskyi	0.60	Shyriaivskyi	0.53
Ivanivskyi	0.65	Ovidiopolskyi	0.64	Odessa city	0.12-0.23

According to the research by scientists of Institute of Dentistry, Academy of medical sciences of Ukraine (city Odessa) with regard to incidence of some dental pathologies

in children of the region it was found out that there exist certain regularities of dental caries and fluorosis spread depending on fluorine content in drinking water. Presence of dental caries in population was identified in all districts of the region (Figure 1).

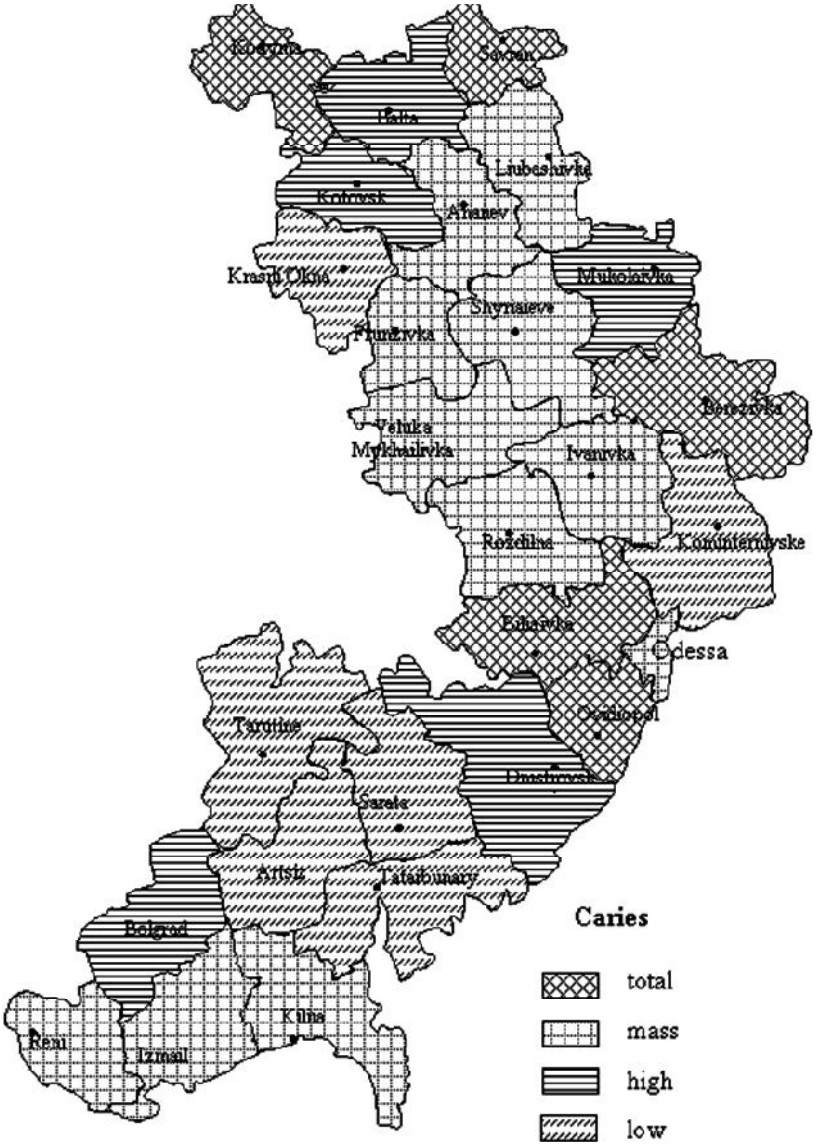

Figure 1. Degree of affection of the population of Odessa region with caries.

In 4 districts (in general on 3 age groups) total spread of dental caries (by WHO gradation), namely, Biliaivskyi, Kodymskyi and Savranskyi districts, is determined. In 5 districts, namely, Artsyzskyi, Kominternivskyi, Krasnooknianskyi, Saratskyi and Tatarbunarskyi districts, (for the same age groups in general) high spread of caries process is determined. Direct dependence of fluorine content in drinking water in the mentioned above districts on indices of dental caries spread is determined. Thus, for instance, in Artsyzkyi districs with fluorine content in drinking water 1.92 mg/l, spread

of dental caries on the average was 37.5%, in Tarutinskyi district with fluorine content 1.84 mg/l, spread of caries process constituted 46.6%. In districts with low content of fluorine in drinking water, as a rule, total spread of caries process was observed. Thus, for instance in Biliaivskyi district with content of fluorine in drinking water 0.21 mg/l, spread of dental caries constituted 95.4%, in Kodymskyi district with fluorine content in drinking water 0.28 mg/l, spread of caries process constituted 93.8% [11].

It was found out there exist certain regularities of dental fluorosis spread depending on fluorine content in drinking water (Figure 2).

Thus, in case of high content in drinking water (higher than TLV) 80% of the population have such dental disease as endemic dental fluorosis. In case of higher fluorine content, 3-5 % of the population of the districts have fluorosis of the first and second degree. Incidence of caries is close to minimal. In case of low concentrations of fluorine in drinking water incidence of caries among the population is 3-4 times higher than in case of the optimal fluorine concentration. Delay of ossification and defects of bone mineralization are observed. Spottiness of tooth enamel of the first degree can be observed in 1-3% of the population [8, 11].

The river Dniester, into which 1-1.5 km^3 of sewage waters are discharged, with the total discharge being 6 km^3, is the main source of water supply for Odessa city. Natural parameters of the mineral composition of the Dniester water though remain adequate for the organism's biological needs, have considerably changed for the last 20 years. The total mineralization has increased, and content of chlorides and other chemical elements has grown [2, 5, 10].

In connection with the global pollution of surface waters centralized water supply of the city is more and more oriented on ground waters. Application of waters from artesian wells from Upper Sarmatian aquifer, located at the depth 108-130 m from the earth surface, is one of the alternative sources of water supply of the population in Odessa city. The total number of wells, drilled in Upper Sarmatian aquifer is 186, with the number of those suitable for use by the population being 134.

Fluorine content in all complexes is low and varies within 0.09-0.23 mg/l, which is very low (resulting in wide-scale affection with caries).

In this connection dental caries is the most spread dental disease among the population. The research aimed at determination of the level of dental diseases among children of different age in Odessa region showed that in the category under 7 years caries was identified in 81.5% of the examined children, in the group of 12 years, spread of caries is 68.8%; in the category of 15 years – 80.86% [11].

Along with high percentage of caries incidence, high percentage of fluorosis incidence is observed. Thus, in the category under 7 years, fluorosis was identified in 78.58% of the examined children; in the category under 12 years, spread of fluorosis is 64.79%; in the category under 15 years, percentage of those who have fluorosis disease constitutes 75.92% [11], which is, probably, connected with identification on the city territory of industrial zones where pollution of the environmental objects with emissions of industrial enterprises, transport, etc. is especially high. Fluorine content in natural components of the mentioned territories is ten and more times higher than the background content and therefore TLV.

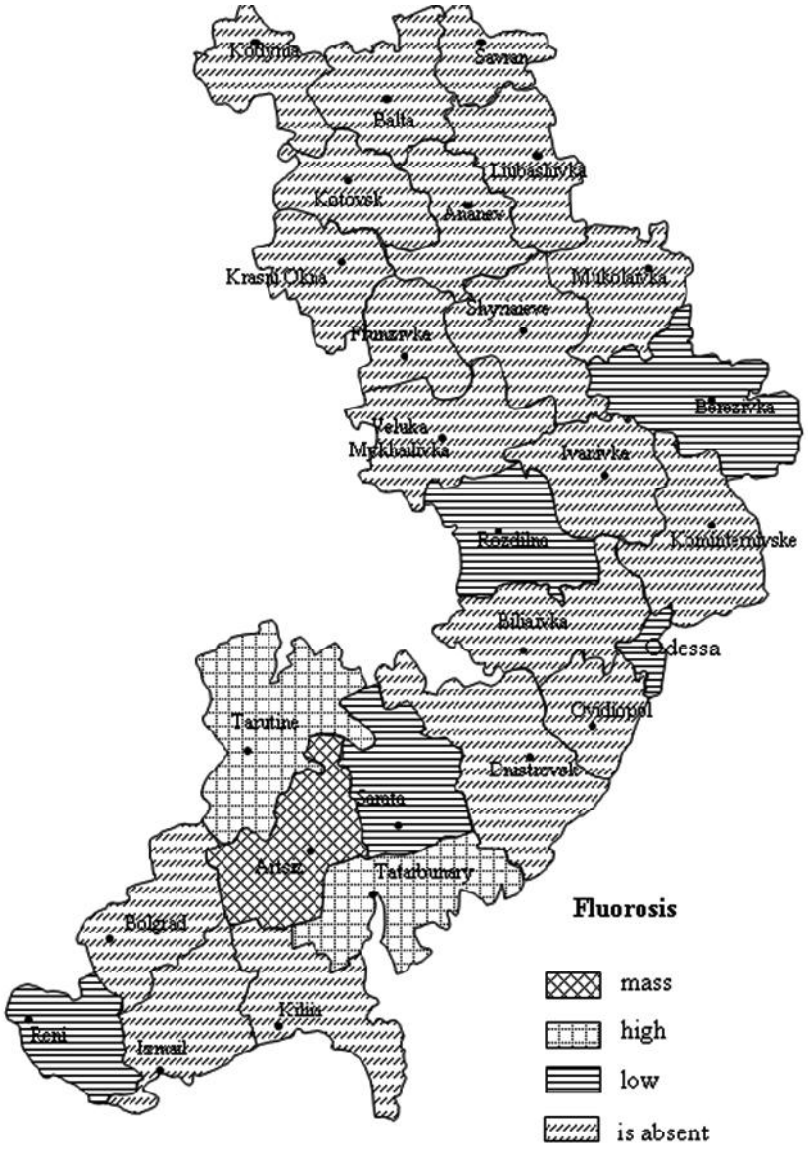

Figure 2. Degree of affection of the population of Odessa region with fluorosis.

Conclusions

1. Fluorine belongs to microelements, which have comprehensive action, and is necessary for normal vital activity of organisms in strictly limited amount.

2. Content of fluorine in natural components has essential impact on its quantitative supply into human organism.

3. Drinking water is one of the main sources of fluorine supply into human organism, and shortage of fluorine in water (below 0.6 mg/l) causes dental caries, and excess (higher than 1.5 mg/l) can cause endemic fluorosis.

4. Content of fluorine in drinking waters of Odessa region varies in wide range from 0.09-1.92 mg/l.

5. Correlation dependence between fluorine content indices in drinking waters of Odessa region and indices of spread of dental disease among the population of the region was established. High level of fluorosis incidence was determined in Tarutynskyi, Artsyzskyi and Tatarbunarskyi districts, where fluorine content in drinking waters exceeds TLV, and high level of caries incidence was determined in Rozdilnianskyi and Biliaivskyi districts, which belong to the zone with low fluorine content.

6. It was determined that high indices of both caries and fluorosis disease are characteristic of the city population, which is connected with identification of industrial areas with considerable anthropogenic load, including fluorine compounds.

7. It is advisable to carry out systematic monitoring analysis of fluorine in natural components of Odessa region in order to prevent incidence of diseases in the population, including dental diseases.

References

1. *Габович Р.Д., Овруцкий Г.Д.* Фтор в стоматологии и гигиене. -Казань, 1969.- 512 с.

2. Звіт про науково – дослідну роботу Інституту стоматології АМН України. 041.01. «Вивчення епідеміології основних стоматологічних захворювань у дітей Одеської області у взаємозв'язку з біогеохімічними факторами оточуючого середовища. 2001. - 341 с.

3. *Лобенко А.А., Надворный Н.Н., Ников П.С., Руденко Ю.С., Ворохта Ю.Н.* Особенности солевого состава воды подземных и открытых водоисточников Одесской области в связи со здоровьем населения // Вісник морської медицини, 1998. - №3. – С. 97–98.

4. *Мудрый И.В.* О влиянии минерального состава питьевой воды на здоровье человека (обзор) // Гигиена и санитария. – 1999. - №1. - С. 15-18.

5. *Нейко Є.М., Рудько Г.І., Смоляр Н.І.* Медико–геологічний аналіз стану довкілля як інструмент оцінки та контролю здоров'я населення. – Л. – Ф.: Екор, 2001. – 350 с.

6. Одеський регіон: природа, населення, господарство: Навч. пос. /*О. Г.Топчієв, І. І. Кондратюк, О. І. Полоса та ін*.– Одеса: Астропринт, 2001. – 184 с.

7. *Перельман А.И.* Геохимия. - М.: Высшая школа, 1979. - 423 с.

8. *Перельман А.И.* Геохимия ландшафта. - М.: Высшая школа, 1975. – 342 с.

9. *Смирнов В.С., Деньга О.В., Мороз О.Б., Петленко С.В.* Состояние имунной системы при эндемическом флюорозе // Иммунология, 1999. - № 6. С. 52 – 54.

10. Стан довкілля Одеської області. Регіональна доповідь про стан навколишнього природного середовища в Одеській області у 2010 році //Причорноморський екологічний бюлетень, 2011. № 3 (41). - С. 7-100.

11. *Тригуб В.І., Позняк С.П.* Фтор у чорноземах південного заходу України: Монографія. – Львів: Видавничий центр ЛНУ імені Івана Франка, 2008. - 148 с.

12. *Тригуб В.І, Ігнат Я.І.* Фтор у природних та стічних водах Південного Заходу України // Вісник Одеського національного університету. Сер. географічні та геологічні науки. - 2011. -Т. 16. - Вип.1. – С. 76 - 85.