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GEOGRAPHICAL ENVIRONMENTAL CHARACTERISTICS OF ENDEMIC FLUOROSIS IN CHINA

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ABSTRACT: Endemic fluorosis is given rise to by human intake of excess fluorine from environment by way of food chain. In China it is one of the extensively prevalent endemic diseases and its distribution shows clearly regional characteristics. In macroscopic sight, three large fluorosis zones may be divided: (1) The arid and semi–arid plains in the north of China. These regions have a dry climate, making fluorine accumulation in the Quaternary deposits. Thus, the drinking water with high content of fluorine is the main cause of the disease formation. (2) The Yunnan–Guizhou Plateau. In the region, rocks and soils rich in fluorine bring about fluorine excess in crop food. This plays an important role in the disease formation. (3) Southeast hills. The hot spring with high content of fluorine leads to fluorosis.

The fluorine absorbed by people from the environment is firstly from the drinking water and secondly from the crop food originating from soil. The fluorine in the air can be accumulated in crop leaves to make an impact on people.

KEY WORDS: endemic fluorosis, leaching, accumulation, food chain, disease zone

Fluorine is a widespread chemical element in geographical environment and the average content in earth's crust is 270 mg / kg[1]. This element is necessary for people but harmful if absorbed excessively. The regional difference of its content in geographical environment is evident according to the facts that in some regions it accumulates abundantly and in other regions it is deficient. Endemic fluorosis is caused when people absorb excessive fluorine from native water, food, or air, which results in disturbing the balance between fluorine, calcium, and phosphorus in metabolization and mottling the tooth enamel or deforming the bone. This paper discusses some regularities and the characteristics of the geographical distribution of fluorosis regions in China.

I. THE TYPES AND DISTRIBUTION PATTERNS OF FLUOROSIS REGIONS IN CHINA

A fluorosis region is defined as the region the inhabitants of which are generally suffering from fluorosis. AS for the fluorosis regions in China, there are two distinguishing points to be described.

1. The Types of Fluorosis Formation

All types of fluorosis formation which are acknowledged in the world can be found in China. They are described respectively as follows:

1) Secondary accumulation type. This type occurs in arid or semi-arid areas. The fluorine-rich weathering materials and runoff are constantly transferred to the flats or low-lying lands, where under dry climate, fluorine concentrates and gradually becomes rich. At last, such places become fluorosis regions. Main regions of this type distribute in the north of China. The leading cause of fluorosis is that inhabitants drink water with high fluorine content (Table 1).

2) Fluorine-rich rock formation or ore deposit type. Fluorine-rich rocks and mineral deposits (including phosphorite, cryolite, fluorite, etc.) before the Quaternary are decomposed when their outcrops are under weathering. This results in the release of fluorine and make it possible for fluorine to take part in the biocycle in soil. At the end, it is transferred to human bodies via food to cause fluorosis. Therefore, high fluorine content in soil is an obvious characteristic of this type. Main disease regions are located in the central part of Guizhou Province.

3) Fluorine-rich hot spring type. Inhabitants suffer from the disease for drinking hot spring water rich in fluorine. There are many fluorine-rich hot springs in China, especially in the granite exposure areas in Fujian and Guangdong provinces (Table 2).

4) Volcanic activity type. During the volcanic eruption, large amount of materials such as volanic ash and lapilli are diffused. They contain abundant fluorine or fluoride, and increase considerably the fluorine content of the air, water and soil. Hence occurs the fluorosis. China has many volcanoes but few are acitve. Besides. volcanoes are mostly located in high mountains or moist and rainy regions. In the former places there are few inhabitants, and in the latter places, due to leaching for a long time, the fluorine released from volcanic eruption has been removed. Therefore, this type of fluorosis is not esay to be found in China. But fluorine in volcanic region is diffused and deposited in their adjacent areas to make them the secondary fluorosis regions. For example, Wudalianchi Volcano in Heilongjiang Province plays an important role in the formation of the fluorosis region in the Songnen Plain. The Datong Volcano region has the same relation with the fluorosis re-

gion of Daton Basin.

5) Fisherman's food type. Some fishermen in the coast area live on sea products such as salt (fluorine content is dozens of ppm) sea fish, and even fish bone (fluorine consent is several hundred mg/ kg) for a long time, so they suffer from fluorosis. This type of fluorosis was reported in Taiwan Province[2].

Table 1 The fluorine concentration in drinking water and the fluorosis incidence in arid region of China*

Province (autonomous region) or city	Fluorosis region	Fluorine concentration (mg/ kg)	Incidence of fluorosis(%)**
Heilongjiang	Zhaodong	1.75–12.4	(1) +(2) 50.0
Jilin	Qiannan	1.5–10.0	(1) 76.3, (2) 56.1
	Nongan	3.0–10.0	(1) +(2) 36.5
Inner Mongolia	Ju Ud League	1.5–10.0	(1) 49.7, (2) 43.1
	Urad Front Banner	0.1–3.8	(1) 60.0
Tianjin	Tanggu	4.0–6.0	(1) 96.0, (2) 3–15
Hebei	Huailai	1.0–2.4	(1) 65.9, (2) 7.7
	Zhangbei	6.0–10.0	(1) 93.0, (2) 30.0
	Yangyuan	1.5–17.5	(1) 84.4, (2) 54.2
Shandong	Shandong Peninsula	0.2–2.4	(1)21.0
Henan	Fengqio	1.0–1.5	(1) 33.2
Shanxi	Linyi	8.1	(1) +(2) 16.8
	Yuncheng	1.5–10.0	(2) 5.0
Shaanxi	Dali	4.3–9.5	(2) 20.3
	Dingbian	3.0–7.0	(1) +(2) 30.8–41
Ningxia	Yanchi	2.6–21.8	(1) 100, (2) 7.7
Xinjiang	Hami	3.2–17.6	(2) discovered

* The information source; Xian Medicine College, The Symposium of Endemic Fluorosis, Vol.1–3, 1979

** (1) is mottling of tooth enamel, (2) is deformity of bone

6) Fluorine pollution type. Many industries produce and release fluorine to thair surroundings, causing serious fluorine pollution, for example, the factories of phosphate fertilizer, smelt–aluminium, steelworks, glasswork, potter, fluoride mill, etc. The Baotou region

of the Inner Mongolian Autonomous Region is a notorious example. But in this paper we discuss natural fluorosis only and do not describe the fluorosis caused by manmade pollution.

Table 2 Fluorine concentration of some hot springs and incidence of fluorosis in China

Province (autonomous region) or city	Location of hot springs	Fluorine concentration of water (mg / kg)	Incidence of fluorosis (%)
Beijing	Xiaotangshan	0.2–8.8	(1) *99.3
Shaanxi	Lishan, Lintong	1.7–6.5	(1) popular
		10.0	severe
Hebei	Tangquan,Zunhua		
Guangdong	17 hot springs in Mei County	4.8–26.0	(1) 51.7
Fujian	*43 hot springs in* Longxi Prefecture	*2.0–17.0*	*(1) popular*
Tibet	Xietongmen county	9.6–15.0	(2)*

*(1) is mottling of tooth enamel,
(2) is deformity of bone

2. Distribution Regularity

The distribution of fluorosis regions is regular. The fluorosis regions are concentrative and continuous, becoming many fluorosis zones, each of which passes many provinces. Each zone has a corresponding region with a main type of fluorosis. In China three large fluorosis zones can be identified (Fig.1).

1) The northern zone. It covers a huge area lying to the west of the Harbin–Dalian railway and to the north of the Gansu–Lianyungang railway and the Kunlun Mountains. It corresponds nearly to the arid and semi–arid areas in China. The aridity is more than 1.0. This zone comprises mainly of fluorosis regions of the secondary accumulation type with scattered fluorosis regions of the hot spring type and the fluorine–rich rock type. Villages subjected to the disease distribute mainly in desert areas and mountainous areas and low–lying lands between high mountains. Those areas include: (a) Marshland or saline–alkali districts in large plains or large basins, such as the Songnen Plain, the western Liaohe Plain, the Qaidam Basin and the Turpan Basin, etc. (b) The districts adjoining sea or saline lakes, such as the coastal plain of the Bohai Gulf, Daihai Lake shore, Baiyangdian Lake shore, Yabrai Lake shore, Lop Lake shore, etc. (c) Intermontane basins or river valleys, such as the Luanhe River valley, Sanggan River valley, Datong Basin, Yancheng Basin, Dali valley, Huailai Basin, etc (d) Internal areism of plateaus, such as Jingbian–Lingwu, Ulanqab Leaque, etc.

The natural landscape in fluorosis regions belongs to steppes of temperate zone and warm temperate zone, desert steppe and saline meadow. Generally coniferous forest and

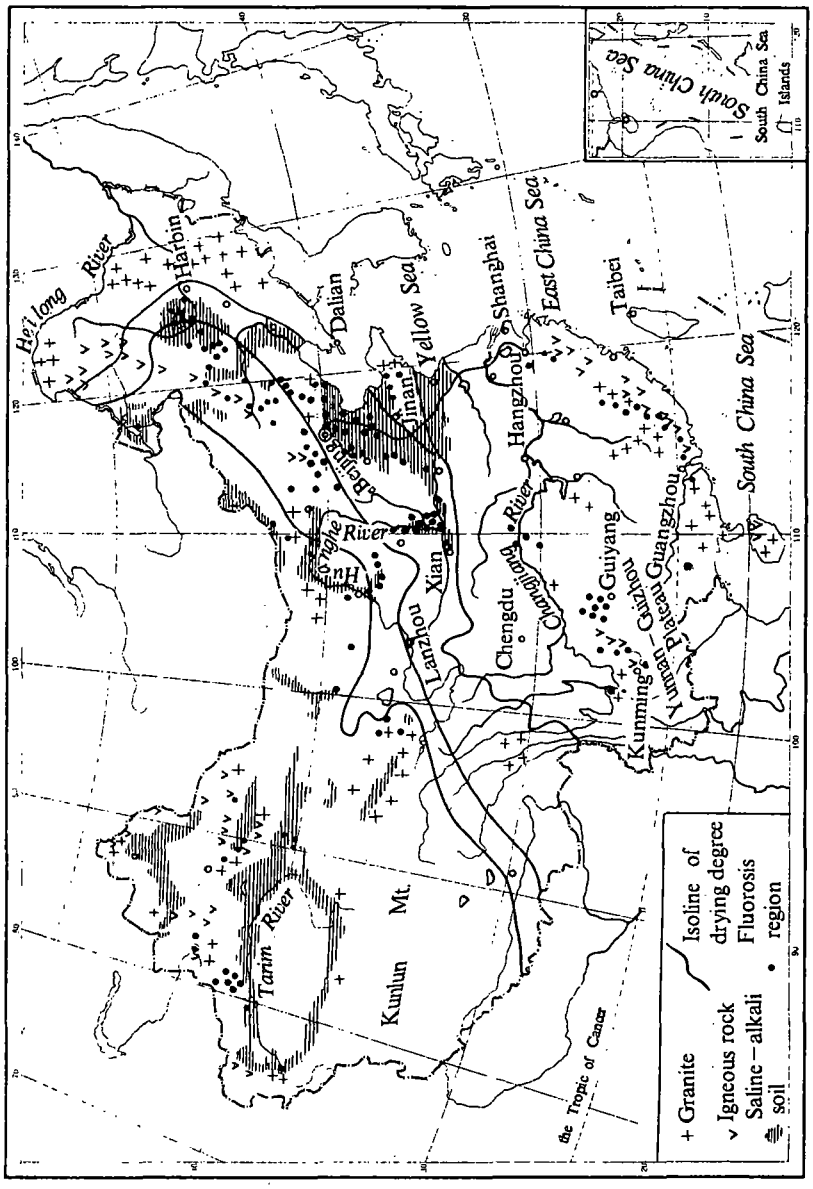

Fig.1 The distribution of endemic fluorosis in China

mixed coniferous and broadleaf forest are not suitable to fluorosis (except the fluorine hot spring type). In some typical districts fluorosis regions and the regions of Keshan desease and endemic goiter do not overlap; but they connect with each other. For example, in the district including the Qinling Mountains and the Weihe River valley, the acid leaching environment of the coniferous forest and the mixtd coniferous and broadleaf forest on high mountains coincides with the endemic goiter region; the neutral environment of the forest-steppe on middle mountains and foothills coincides with the Keshan disease region and the alkaline environment of the steppe or meadow on the river valley lowland coincides with the fluorosis region. They join together to form a spectrum of successive distribution of endemic diseases. The leading factor causing fluorosis in the northern zone is the high fluorine concentration of undergound water or shallow pressure water in the Quaternary formation. The inhabitants who drink snow water or external river water generally do not suffer from fluorosis though they liver in the zone.

2) The zone of Yunnan-Guizhou Plateau. This zone starts from the west of Hubei Province passes through the central and western parts of Guizhou Province, and ends at the Longchuan River valley of Yunnan Province, forming a narrow fluorosis zone. It is located in subtropical evergreen forest zone with moist climate. The disease is caused by fluorine-rich rocks. The epidemical regions correspond to the outcrops of fluorine-rich rocks. Main fluorosis regions concentrate in: (a) some counties of Enshi Prefecture in Hubei Province; (b) Bijie Prefecture and some of its adjacent counties in Guizhou Province; (c) some border regions between Yunnan, Guizhou and Sichuan provinces; and (d) the eastern and northeastern parts of Yunnan Province. The fluorine-rich strata appear and disappear alternately on surface as a result of folding and faulting, so that the disease regions and the non-disease regions interlock or crisscross each other. In this zone, the fluorine content of water is low but that of soil is high. Additionally, there are some special disease regions in the zone, which are caused by grain polluted by fluorine from air.

3) The zone of the Southeastern Hills. This zone starts from the hills in the northwest of Zhejiang Province, passes through Longxi Prefecture of Fujian Province, and ends at Mei County ard Huiyang City, forming a narrow belt trending northeast and southwest. It is corresponding to the Southeastern Hills of China in geomorphology. The main cause of its formation is hot springs with high fluorine content. The fluorosis regions distribute within the areas where granite is exposed. Generally they are small, only confined to some villages influenced by hot springs.

II. CHARACTERISTICS OF PHYSICAL GEOGRAPHY OF FLUOROSIS REGION IN CHINA

1. Particular Geological Environment

The characteristic of environmental geology of China's fluorosis region shows mainly in the relationship between the formation and distribution of fluorosis regios and the distribution of fluorine-rich strata. However, the form of expression varies with the type of fluorosis region.

1) Hot spring type and rock type of fluorosis regions. The geological backround of the former relates to the distribution of magmatic rock and partly to volcanic activity; the latter has a typical example in the central part of Guizhou Province, and relates to the following rocks or strta: (a) Sedimentary rocks produced by ancient volcanic eruption. They were formed in the era from the early Permian period to the late Permian period. The fluorine content in weathering crust originating form the strata is 912-1064 mg / kg, which causes fluorosis. (b) Sedimentay rocks of shallow alkaline-sea. They are the deposits of ancient shallow-sea facies, contain the maximum fluorine and often precipitate as fluorite especially in the late period of dolomitization and the early period of sulphate formation. They belong to the late Cambrian system and the middle and early Triassic system. The average fluorine content in dolomite is 462.21 mg / kg, and the largest content 986.6 mg / kg. The fluorine content of soil originating from the dolomite is close to 1000 mg / kg, jeopardizing the inhabitant's health. (c) Fluorine-rich ore deposits. It mainly belongs to the phosphorite ore deposit of marine facies and fluorite ore. The fluorine content of the rocks is over several thousand ppm; but their distribution is limited.

2) Arid secondary accumulation type of fluorosis region. Its geological character can be described as follows: (a) It distritutes strictly within the Quaternary stratum. Horizontally there is no fluorosis outside of the Quaternary stratum and vertically we can discover low fluorine waterbearing stratum when drilling underground through the Quaternary stratum. (b) The material of the Quaternary stratum comes from its surrouding raised ranges which since the Meozoinic Era have been subjected to denudation and weathering for a long time accompanied by volcanic activities many times. Deposition and denudation are related in origin. (c) The deposits include river-lake facies, estuary facies, neritic facies, and loess deposit, etc. The common characteristic is that they contain fluorine-rich minerals such as fluorite, phosphorite, hornblende, taurmaline, etc. (d) Correspondingly the Quaternary alluvia contain abundant fluorine. For example, the fluorine content of the alluvia in the Songnen Plain is 440-580 mg / kg; that of the Loess Platean 500-600 mg / kg; and that of the cave alluvia of Zhoukoudian in Baijing 800-900 mg / kg. (e) The Quaternary alluvia in fluorosis regions contain abundant sulphide, chloride, etc. For example, the Wushuang flood plain in Heilongjiang Province is a serious fluorosis region. This area is a closed basin of salinization, and its alluvia contain abundant gypsum, mirabilite, soda, and salt. These facts indicate the dry environmental character of the area.

2. Geographical Environment Favourable for Fluorine to Be Released from One Place and Accumulated in Another

1) The formation of the fluorosis region of the hot spring type is generally not influenced by topography. The fluorosis region of the rock type is mostly located in syncline or the core part of anticline with a gentle ground surface. The low-lying and closed location favour fluorine deposit. Therefore in the Yunnan-Guizhou Plateau, the regions where the fluorine-rich rock is exposed and the topography is low land are fluorosis regions. On the contrary, the regions where the fluorine-rich rock is lacking or the topography is precipitous are not fluorosis regions.

Secondly, the formation of the fluorosis region of the rock type relates to the subhumid climate of the subtropics. Although the disease region within the Yunnan-Guizhou Plateau is located in moist zone, but it is relatively arid compared with its surroundings. For example, the annual rainfall of the fluorosis region in Yunnan is 600-800 mm and the runoff depth 150-200 mm; both are much less than those of the non-fluorosis regions. This kind of climatic condition is beneficial to both the weathering of the flourine-rich strata and the releasing of fluorine. Meanwhile, it is also beneficial to the formation of clay minerals, so the soil in the region contains a great deal of clay minerals, such as chlorite, kaoline, etc. All of them can absorb fluorine released from rocks. Futhermore, soil contains a large quantity of Fe, Al, and B; they can combine with F to form complex compounds reducing the loss of fluorine through surface runoff. As a result, the fluorine content of soil in fluorosis region is up to 500 mg / kg, and sometimes it is even over 1000 mg / kg. The fluorine content of the surface water and groundwater is low, being only 0.1-0.5 mg / kg. The grain yielded in this kind of soil is a dangerous cause of fluorosis in the Yunnan-Guizhou Plateau.

2) The fluorosis region of the arid type sets up another pattern of fluorine accumulation. Its regional characteristic is that the pography is a closed basin and the climate an arid centre. The fluorosis region is located in the centre of an arid area, but its surroundings are leaching areas because of elevation and relatively moist climate. The fluorosis region is the area where the runoff not only conveges, but also is evaporated. The annual evaporative capacity is over 2000 mm. It is impossible for the water inside and outside the region to exchange. The water cycle belongs to permeate-evaporate type. The phreatic water of an arid region is near the surface and covered only by loose soil, so that water is easy to be evaporated. It is possible for the fluorine in water to concentrate to a dangerous level that causes fluorosis.

3. Ecological Environment of the Dry Farming Land

1) The fluorosis region of the rock type in Yunnan-Guizhou Plateau distributes in acid environment. It belongs to the weathering crust rich in Fe and Al, and is beneficial to the formation of complex compounds AlF^{2+} and AlF^{2+} for plant absorption. Meanwhile

the soil contains much B in favour of absorbing and accumulating F by crops[3]. Corn and wheat are main crops in dry farming land; they are not favourable to fluorine leaching. So the fluorine content of crops is generally high; most of the contents are 10 mg / kg or more being harmful to human health.

2) The fluorosis region of the arid type in the north of China takes the saline environment as the feature. The disease region is a broad zone extending steppe soil, desert soil, and alkaline meadow soil. The outstanding characteristic is that the soil is rich in calcium. The contenf of CaO is 5–20%, called calcareous soil. It must be pointed out that the area covered with calcareous soil is only located on the edge of the fluorosis region; the real fluorosis region coincides with the area covered with saline–alkali soil; and the history of the development of some fluorosis regions is parallel with the history of the salinization and alkalization of the soil. The saline content of the history of the salinizatin and alkalization of the soil. The saline content of the soil in the fluorosis region is 0.2% to 3%. There is salt crust on soil surface in some disease regions. The salts are composed of sodium bicarbonate and sulfate; and the pH value is 8.0 to 8.5. The fluorine content of the soil varies greatly from 150–400 mg / kg in the Songnen Plain, Yanchi, and Baotou, etc. to over 2000 mg / kg in Qaidam of Qinghai Province.

Land in fluorosis region is used as cultivated land or pastural area, where both natural plants and crops have high fluorine content. The fluorine content of the herbage in Balongtan of Qinghai is 39–186 mg / kg (in contrast with this, in the Chengdu Plain it is less than 10 mg / kg). The fluorine content of grains varies greatly: for corn it is 1.5–38.2 mg / kg; wheat 15.0 mg / kg; soybean 0.2–5.0 mg / kg. Native livestock suffer fom fluorosis as well. The incidence of mottling of tooth enamel of goats in Balongtan is 84.7–91.1%, sheep 100%, and camel 100%. The fluorine content in the bone of them is 3930–5000 mg / kg, which is seven to eight times higher than the normal level.

4. Geochemical Charecteristics of Fluorine Accumulation in Disease Region

In the arid disease zone in the north of China the geochemical process of fluorine accumulation has two typical characteristics.

1) The formation of the fluorosis region is attributed to that the fluorine in the primary fluorine–rich rock stratum is leached and carried down to the low–lying land to accumulate. The series of mountain → piedment hills → rolling plain →low–lying land is corresponding to the series of leached region → leached and filtrated region → salt deposit region → excessive salt accumulation region. Accordingly there forms a series of groundwater type, which is HCO_3^-–Ca^{2+}–Mg^{2+}→HCO_3^-–SO_4^{2-}–Ca^{2+}–Mg^{2+}→HCO_3^-–SO_4^{2-}–Na^-–Ca^{2+}→ SO_4^{2-}–Cl^-–Na^-. At last, there occurs a scries of regions, which is fluorine–deficient region → normal fluorine content region → light fluorosis region → severe fluorosis region. All processes and their corresponding landscape types are shown in Table 3. This is a typical

example of the arid type of fluorine accumalation in northeast China.

Table 3 Relationship between the groundwater composition and the fluorosis region in the Yitong River watershed of Jilin Province

Location	Upper river	Middle river	Lower river	Areism
Topography	Low mountain and hill	Hill and terrace	rolling plain	Salinized low land
Crust of weathering	Unsaturated silicon and aluminium	Accumulation and residue	Accumulation	Salt-rich accumulation
Chemical process	Leaching and alimentation	Solution filtrates	Soluble salt begins to accumulate	Soluble salt accumulates in quantity
Rainfall(mm,annum)	600–700	500–600	400–500	300–400
Depth of runoff (mm,annum)	100–200	50–100	25–50	< 25
Runoff coefficient(%)	> 20	10–20	5–10	< 5
Ca^{2+}	0.14	55.18	178.34	52.3
Mg^{2+}	6.17	10.09	30.70	44.9
$K^{+}+Na^{+}$	19.11	21.35	33.10	433.3
Fe^{3+}	3.78	0.95	0.15	0.00
HCO_3^-	87.25	125.79	305.57	1076.80
Cl^-	26.97	40.88	167.67	150.00
SO_4^{2-}	8.40	33.32	145.90	151.30
F^-	< 0.5	0.5–1.0	1.6–5.0	> 5.0
pH	6.7	7.1	7.2	7.5
Relation with fluorosis	Lack of F	Norm al F content	Light fluorosis	Severe fluorosis

Note: The calculation unit for ions is mg / kg. Ions are in groundwater.

Source: Changchun Institute of Geography, Dili Jikan (1), 1978.

2) The calcium-rich weathering crust of macroscopic environment and the saline-alkali process of microscopic environment exist together and influence each other. Generally, the real fluorosis regions are located in saline-alkali areas which are surrounded by calcium-rich weathering crust. Calcium is an anti-fluorine element. It can combine with fluorine to form a deposit of CaF_2 when fluorine is leached from the surrounding areas and enters into the calcium-rich weatering crust. For this reason, the fluorine concentration of water here is low, so it does no or slight harm to people. But in saline-alkali enviroment with relatively low calcium and high sodium, groundwater belongs to the type of HCO_3^--Cl^--Na^+. The activity of Na^+ increases and it is difficult for Ca^{2+} to combine with F^-[4]. So the activity of F^- increases as well. But fluorine here is derived from the calcium-rich environment owing to leaching. In view of the whole country, fluorosis zone shows basically conformity with the calcium-rich weathering crust. But the real disease regions occupy only the saline-alkali areas, which lie inside the calcium-rich weathering crust like lensbodies inserted into it. It means that there are many small calcium-deficient

environments within a large calcium-rich environment. The disease regions and non-disease regions are different but they compensate each other.

III. AN ANALYSIS OF ENDEMIC FLUOROSIS IN LIGHT OF FOOD CHAIN

1. Relationship between the Fluorine in Air and the Incidence of Fluorosis

Fluorine is an abnormal composition of air. It means that there is very little fluorine in normal air. Its content in air, according to Bower (1960), is less than 0.01 $\mu g / m^3$. It is reasonable to say that human intake of fluorine from air is very little. If air is polluted by fluorine released from industry or volcanic eruption, it can do harm to human health. According to investigation, the workers engaged in phosphoric fertilizer and steel making have high fluorine content in their urine and suffer from pathological changes of nervous system and respiratory tract. The inhabitants who live in serious fluorine-pollution region for a long time suffer from mottling of tooth enamel or deformity of bone. The investigation results from different natural zones show similarity.

Another way for fluorine in air to affect human health is that fluorine is absorbed by plants, then through plants transferred to human body. The amount of fluorine absorbed by green plants from air and accumulated in their leaves can be one million times as large as that in air. In the region with fluorine-polluted air, the amount of fluorine imbibed by plant leaves is several to hundred times higher than that in plant leaves in normal environment. According to my research, the result shows that the fluorine content of most plant leaves in fluorine pollution area is over 100 mg / kg and that the maximum is more than 3000 mg / kg. For this reason, it is a very common phenomenon that the ruminants feeding on fluorine-polluted herbs are poisoned by fluorine. However, gains absorb and accumulate much less fluorine from air, being generally less than 10 mg / kg. So the inhabitants who live on gains (rice, corn, wheat, soybean, etc.) do not suffer from fluorosis. But when they eat vegetable leaves, they assimilate much more fluorine.

A special fluorosis caused by air fluorine pollution is found in Guiyang City of Guizhou Province and Enshi Prefecture of Hubei Provience. There the inhabitants dry their food grains by burning coal in house. The fluorine released from coal is absorbed by food grains. The fluorine content in corn is 8.7-53.3 mg / kg (the average is 26.3 mg / kg) and that in chilli is 310.5 mg / kg. The incidence of fluorosis is 86.8-99.6%[5]. Generally, the conclusion is that fluorine of air can affect human health through several ways.

2. Relationship between Fluorine Content of Soil and Incidence of Fluorosis

The fluorine content of natural soil varies greatly from 10 mg / kg to 7000 mg / kg, and the average is 200 mg / kg. The fluorine in soil does not affect the plants so clearly as

that in air. It means that the quantity of fluorine absorbed by plants from soil has no clear relation to the fluorine content of soil. The analysis based on over one hundred samples taken from different places shows that fluorine content of leaves of natural plants growing on normal soil is 2—30 mg / kg. The ratio of fluorine content of plants to that of soil is 0.01 to 0.05. The fluorine absorbed by plants from soil is accumulated mainly in roots, and there is not much in fruit. But if the fluorine content of soil is over 500 mg / kg or soluble fluorine is over 10 mg / kg, plants may absorb and accumulate a great deal of fluorine. The fluorine content of fluorine—rich soil in China is mostly over 500 mg / kg. In these places, the fluorine content in gains of wheat, corn, rice is about 10 mg / kg, and it reaches 20—30 mg / kg occasionally. So fluorine—rich soil can be the main cause of fluorosis in some particular areas.

3. Relationship between Fluorine in Drinking Water and Incidence of Fluorosis

High fluorine content of drinking water plays an important role in most of the fluorosis regions in China. In non—fluorosis regions of south China, the fluorine content of surface water and shallow groundwater is generally 0.01—0.20 mg / kg. Only in a very few regions it is over 0.5 mg / kg. In fluorosis region the fluorine content of drinking water is over 1.5 mg / kg, and in most of such regions it is about 2—10 mg / kg. The incidence of mottling of tooth enamel and deformity of bone relates to the fluorine content of drinking water, on the basis of the epidemic investigations in dozens of fluorosis regions large or small in north China. The number of years the inhabitants drink water is related closely to incidence of fluorosis. It shows a positive correlation between the incidence of fluorosis and the number of years the people drink high fluorine water. In the same area, the older the inhabitants are, the higher their incidence becomes. An eloquent proof has been produced that in north China fluorosis symptoms can be alleviated through reducing the fluorine concentration of drinking water or drinking low fluorine water. Finally, a change in chemical composition of water influences fluorosis formation and development too. In fluorosis region, the water bodies are characterized by high active fluorine and low active calcium. And the ratios of fluorine to hardness, fluorine to calcium, and fluorine to magnesium in fluorosis regions are by far larger than those in non—fluorosis regions. In short, the fluorine concentration and chemical composition of water strongly affect the formation of fluorosis regiongs.

The key of preventing and curing fluorosis is to get rid of high fluorine from environment. A strategic measure to be taken is to improve the environmental quality of the high fluorine regions, so that the tendency of fluorine accumulation can be changed and the fluorine removed. On the other hand, it is necessary to break the food chain so as to prevent fluorine intake by people, such as drilling deep wells to get low fluorine water, not eating high fluorine food, etc. To improve nutrition and to accelerate excreting fluorine from

human body are also significant.

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