# Analysis of Groundwater Component and Its variation in Saga Plain

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## 1.Introduction:

Groundwater is a existing state of hydrology cycle. As an important natural resource, the groundwater utilization requests not only enough water quantity, but also good water quality.

Generally groundwater has its regionalism. The groundwater quality is affected by its recharge resources such as rainfall, river water, irrigation water and the geology, geography property of its container and the soil utilization, aquifer characters. In the study, the groundwater chemical component analysis is used to analyze the groundwater flow mechanism and the relation with geological condition in Saga plain.

## 2.Geological Condition:

Saga plain is made by alluvial process of rivers. Its north, west and east are mountain sites. Its south is Ariake sea. The Chikugo, Kase and Rokoku are the main rivers flowing though Saga plain. They flow from the mountain sites, finally into the Ariake sea.

The soft Ariake clay is extensively distributed in the surface of Saga plain. Underneath the clay layer, there are unconsolidated sedimentary layers that mingled by sand and mud. The layers of Saga plain are divided into A, B, C, D, E and F formations. The top Ariake clay layer called A formation, deposition in alluvial transgression and regression, is mainly composed of very soft silt and clay with a variable thickness. The B formation called Shimabara bay formation, probably diluvial marine deposit, mainly composed of sand. It is the water resource of shallow wells. C formation (pumice-bearing volcanic ash formation) came from Aso mountain as pyroclastic flows, arised about 33 thousands years ago. D, E and F formations are diluvial beds. They consist of marine sand and silt. D is the second aquifer in this area but not a good one. E is the main aquifer from where water is pumped now. F formation has fairly compact silt and fossils of wood in itself.

## 3.Sample Spots:

This time 30 samples of Saga district are analyzed. IM-5S Ion concentration measure is adopted to analyze the ion of $Na^+$, $K^+$, $Ca^{2+}$ and $Cl^-$. The ion of $Mg^{2+}$, $HCO_3^-$ and $SO_4^{2-}$ are analyzed by Saga prefecture. According to the geological property of Saga plain, these samples is divided into three groups. They are shallow well group(strainer depth <50m), medium well group(strainer depth is about 100m), deep well group(strainer depth is about 200m).

## 4.Test Result and Discussion:

The hexa diagram is adopted to express the test result. Fig.1(a), (b), (c) show the property of groundwater chemical component in shallow wells, medium wells and deep wells in Saga district.

It is found that the samples of deep wells almost have same pattern and show a property of normal groundwater. In medium wells, the samples from south coastal area show very different pattern with that in inland area. The result of shallow wells also show same tendency with that of medium wells. The data show that in same depth the ion concentration of $Na^+$, $K^+$, $Ca^{2+}$, $Mg^{2+}$and $Cl^-$ show an increasing tendency from inland area to coastal area. It also can be seen the ion concentration of $Cl^-$ show an increasing tendency from deep wells to shallow wells.

Before pumping restriction, a large quantity of groundwater was pumped in shallow aquifer (the first aquifer) centrally. The groundwater level varied by pumping amount in season. Then sea water intrusion occurred due to low water in shallow aquifer. After restriction, water is mainly pumped in medium or deep aquifer (D or E layer), then sea water intrusion is spreading from shallow wells to mediums gradually.

The degree of sea water intrusion is expressed by item E. For instance, $E_{Ca}$=[($Ca^{2+}/Cl^-$)of groundwater/ ($Ca^{2+}/Cl^-$)of sea water]. The value of E more near to 1, the groundwater component more near to that of sea water. Fig.2 show a relation between $E_{Ca}$ and ion concentration of $Cl^-$. It can be seen in some area the $E_{Ca}$ value is over 1. The groundwater in some areas is polluted by sea water intrusion.

## 5. Tritium Concentration:

Tritium is the isotope of hydrogen. By measuring its concentration in groundwater, the groundwater age, water flow direction and recharge resource can be estimated.

In shallow aquifer samples, either in inland area or coastal area of Saga district, groundwater shows young age. In inland area, it is considerable that aquifer is recharged by surface water from northern mountain sites. But in coastal area the reason may be that groundwater was intruded by sea water. In deep aquifer the groundwater in inland area shows old age of normal stagnation and that in coastal area shows young age. The phenomenon is considered as the result of large quantity pumping before restriction, the low water is occurred in where pumping is concentrated, then induce to the sea water intruded in aquifer that near to the coastal line. As the result, the groundwater there is mingled by sea water, the tritium concentration there then become bigger and show the young age.

## 6. Conclusion:

According to the analysis of groundwater component in different aspects, it is concluded that in Saga district, the recharge is rainfall or river water from northern mountain site. By over pumping in Saga district, sea water intrusion due to low water has intruded into aquifer from south, especially in shallow aquifer. In coastal line, even groundwater in deep aquifer has been intruded by sea water.

Over-pumping caused groundwater level varied then induced to the variation of ion concentration in groundwater. In coastal alluvial plain such as Saga plain, it often result in sea water intrusion.

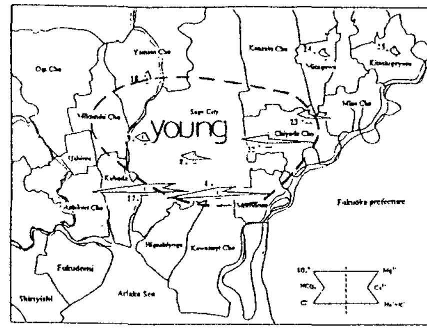


*Fig.1(a)* **The property of groundwater quality in shallow wells**

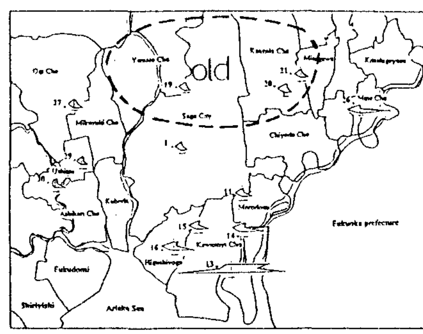


*Fig.1(b)* **The property of groundwater quality in medium wells**

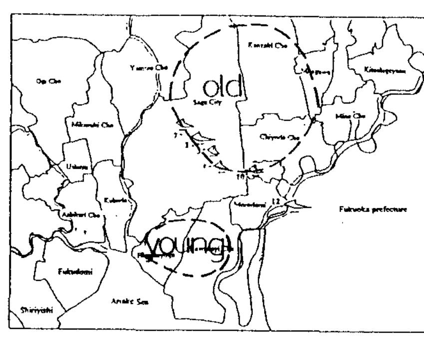


*Fig.1(c)* **The property of groundwater quality in deep wells**

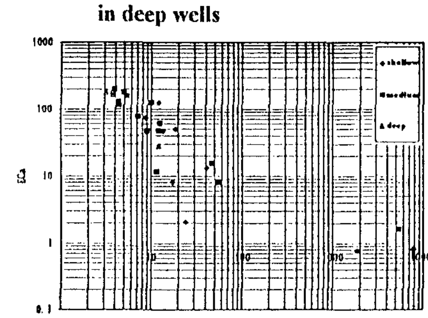


*Fig.2* **The relation between $E_{Ca}$ and concentration of $Cl^-$**

## References:


1. Khamehchiyan,M & Iwao,Y(1993)"Geotechnical Properties of Ariake Clay In Saga Plain" Proceeding of The International Conference on Soft Soil Engineering, GuangZhou, China (in English)
2. Miura,N & Yisakai,K & Sakayi,A & Toyino,Y(1986)"Land Subsidence and Quality of Groundwater in Saga Plain" Tsuti－To-Kiso JSSMFE Ser.No.346,Vol.34,No.11 (in Japanese)