Fluoride MAWARI Project

➲ETHIOPIA

Origin, Genesis and Distribution of Fluoride in the Ethiopian Rift

Development of Defluoridation Technologies

November 20-24, 2007
Addis Ababa, Ethiopia

Rundown

A) Overall Perspectives

- ✓ Accomplished
- ✓ Milestones

B) Activities of the last six months

- ✓ Specific Objectives, Expected Results of the Period
- ✓ Scheduled Activities for the Next 6 Months

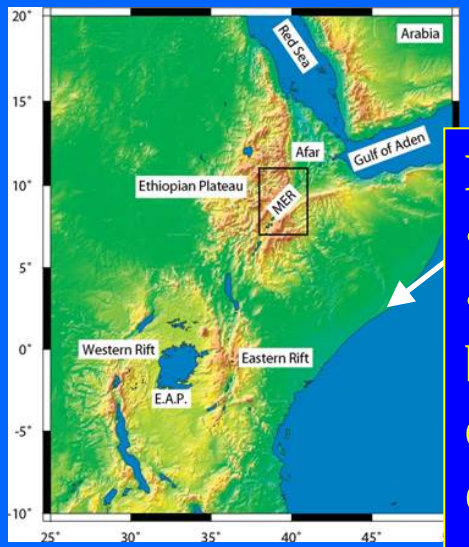
C) Scheduled Activities for the Next 6 Months

A) Overall Perspectives

Accomplished

In-depth literature survey on the origin, genesis; and defluoridation (local and international);

- ➲Improved knowledge on fluoride source, genesis, distribution in the Rift and defluoridation methodologies worldwide
- ➲Improved regional awareness and exposure

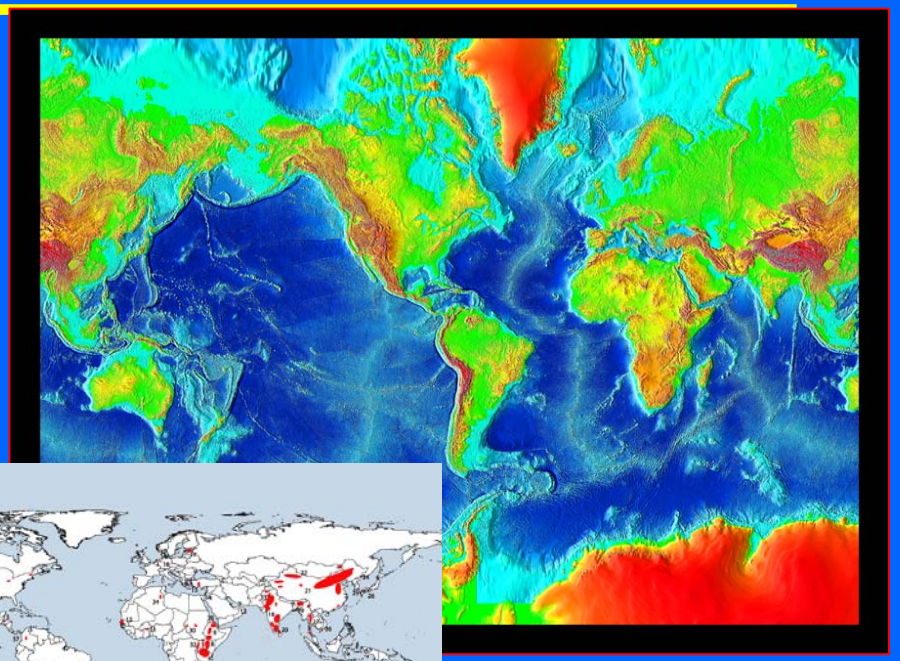


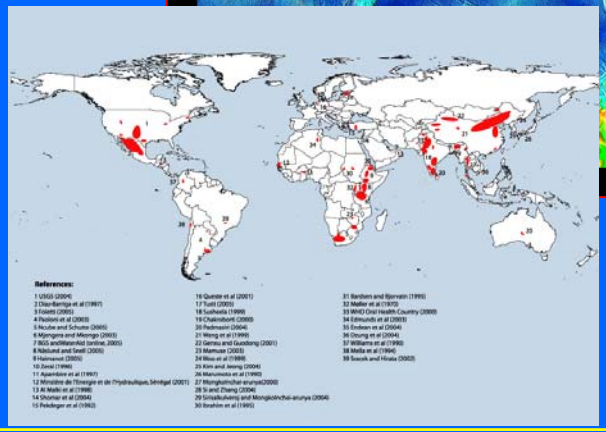
Better knowlegde on:
- **Geological controls**
- **Fluid evolution-boiling, mixing, evaporation, dissolution impacts**

A) Overall Perspectives

Accomplished

➲Compilation of available local and international geoscientific and defluoridation related information;

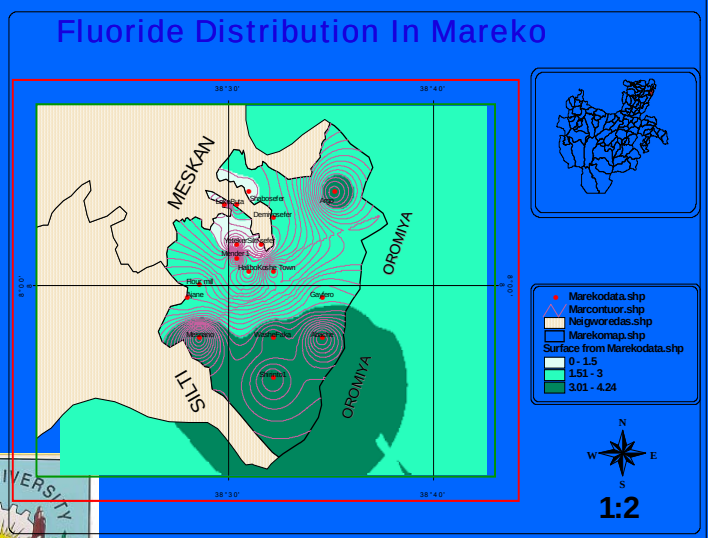


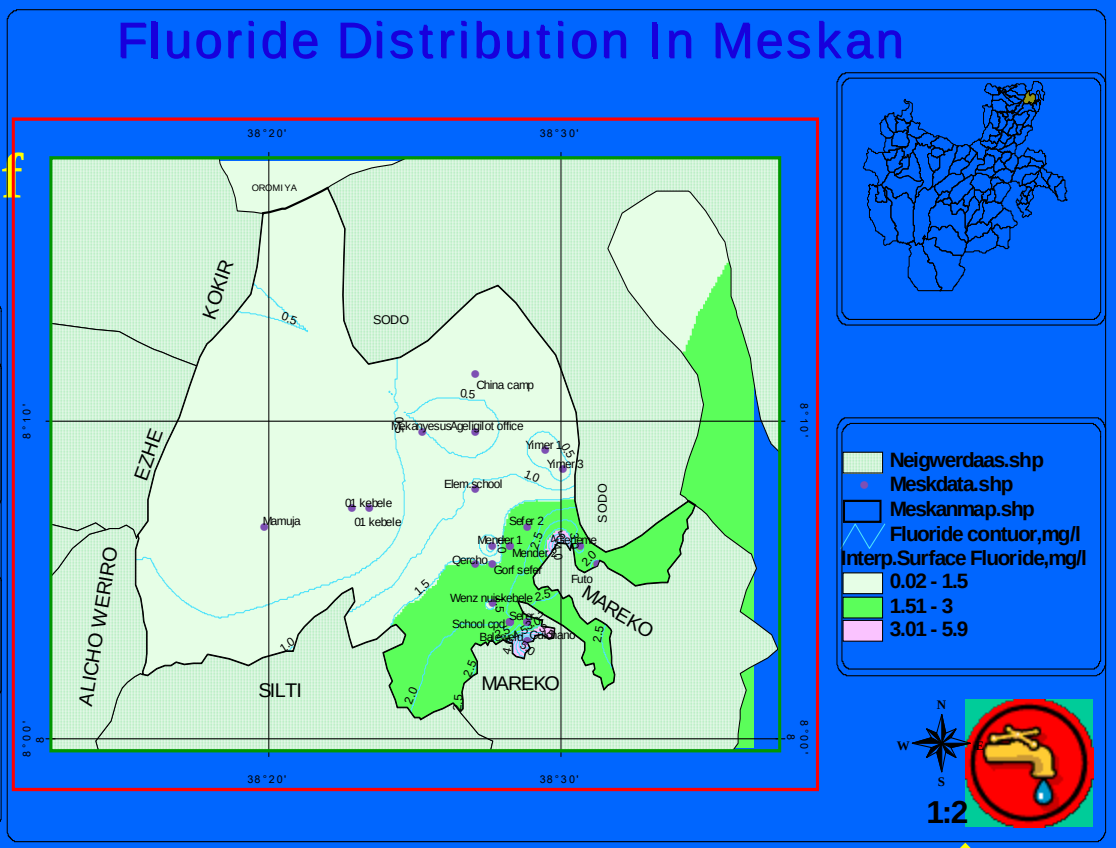


A) Overall Perspectives Cont.

Accomplished

➲General fluoride distribution mapping of the MER (Eth); and

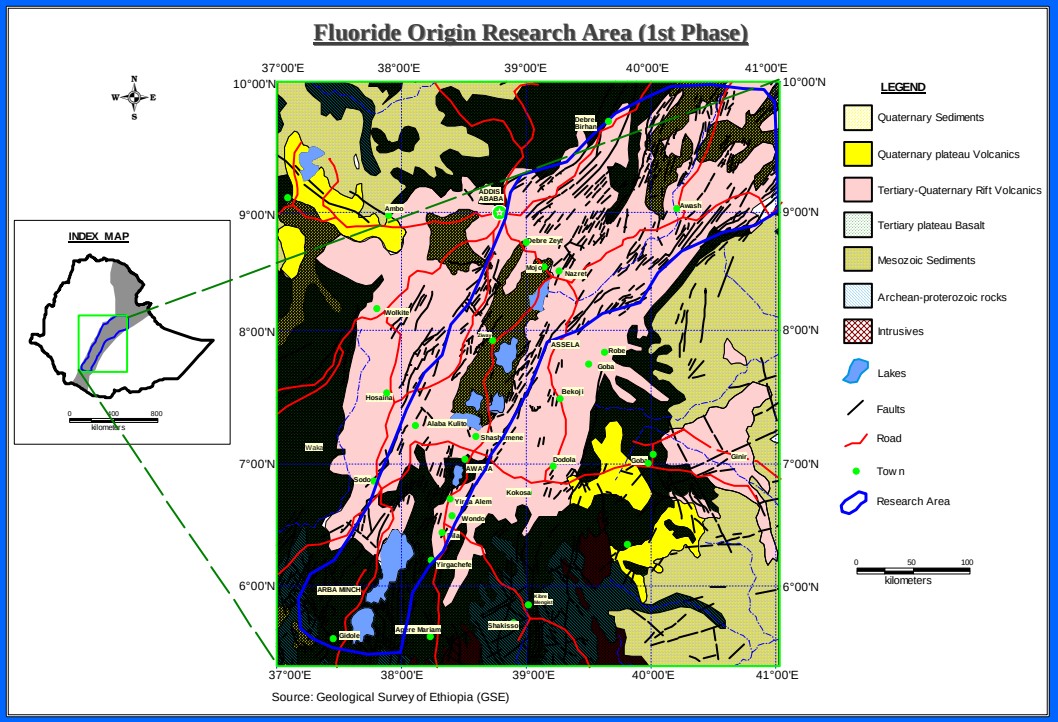




A) Overall Perspectives Cont.

Accomplished

➲Identified y model areas for detailed evolutionary; mineralogical and geochemical controls; and detailed distribution mapping investigations.



A) Overall Perspectives Cont.

Accomplished

➲Field investigation on the Iron Oxide Coated Sand has been made;

A) Overall Perspectives Cont.

Accomplished - Defluoridation Experiences of Ethiopia

Method	Advantages	Disadvantages	Remark
Aluminum sulphate with lime	- Good yield - Materials locally available - Not highly labor intensive - Easy to install/operate - Fast removal - Affordable running cost	- Sludge production - No regeneration - Initial investment cost - Limited feasibility for F > 10 mg/L - Limited feasibility to lower F < 3 mg/L - Introduces Al^{3+} and SO_4^{2-} - Difficult to monitor in rural areas	- Highly favored by communities
Bon Char	- Material available - Less expensive - High F removal capacity	- Bad color, odor and taste - Visually unattractive – Cumbersome material prep. - Conflicts with local culture - Shortage in raw bones, especially in remote areas	- Rejected by local communities - No regeneration - Cost still to be investigated
Natural Clay	- Material available - Less expensive	- Low fluoride removal capacity - Labor intensive and time taking - Color not attractive	- Less preferred by communities
Activated alumina (Large scale)	- Efficient	- Expensive - Difficult to operate and maintain	Experienced decades back

Milestones

Source, Genesis and Distribution- Model Area

- **Conduct intensive field geochemical investigations and laboratory determinations on the water and gas samples as appropriate;**

- **Undertake detailed filed geochemical and water-rock interaction experiments and mineralogical studies on rock samples; Study the groundwater flow system**

Milestones

Source, Genesis and Distribution- Model Area

- Study the groundwater flow system
- Investigate and when possible quantify the source and detailed mechanisms of fluoride evolution;
- Produce a detailed fluoride distribution mapping for the model area both in water and rock bodies; and
- Performing - processing and integrated interpretational work

Milestones Cont.

Defluoridation

Target - developing efficient water defluoridation techniques (household and community scale) based on locally produced materials

Milestones Cont.

Defluoridation

- **Investigate fluoride adsorption mechanisms and derive proper modelling algorisms (adsorption isotherms) from natural waters of the Rift onto clays, alumina, and other potential surfaces:**
  - **The effect of- mineralogical and structural characteristics,**
  - **Fluoride solution chemistry,**
  - **Surface properties of the sorbents i.e., size, surface area,**
  - **Physical and chemical pre-treatment procedures, etc);**

Milestones Cont.

Defluoridation

- Study the kinetics of the adsorption process and verify the kinetics of the adsorption process of the given materials;
- Conduct the study both in batch and continuous mode of flow at laboratory and pilot scale in order to use the technology in both systems;
- Develop designing parameters;

Milestones Cont.

Defluoridation

- Design a prototype of possible defluoridation schemes;
- Develop operation procedure for batch and continuous flow systems;
- Establish a regeneration mechanism for the reuse of the exhausted material after defluoridation; and
- Evaluate the cost and technical feasibility of the process.

B) Activities in the last six months

I. Specific Objectives, Expected Results of the Period

1. Revising Project Programme and Its Human Resources

After consulting the team and the Addis Ababa University as a main partner, the following readjustment measures proposed:

1. Revising Project Programme ..Cont.

Defluoridation Part –

➲A focused and sustained research on defluoridation shall be backed up by a PhD student - adsorption investigations using activated alumina;

➲Involve two new senior researchers in defluoridation research, namely, Dr. Ghirma Moges and Dr. Alemayehu Mekonen especially at an advisory level;

1. Revising Project Programme ..Cont.

Source, Genesis and Distribution- Part

- One senior researcher in volcanology / Geochemistry, Dr. Gezahegn Yirgu to join the project;
- Sponsor a PhD student to work on the Source and Genesis part of the research;

1. Revising Project Programme ..Cont.

Source, Genesis and Distribution- Part

- A readily available, professionally motivated young hydrogeologist, who has a GIS/Modelling orientation was recommended to join the project from the GSE;

- Involvement of MSc students as appropriate in both parts of the project.

1. Revising Project Programme ..Cont.

Status

- *The proposed PhD candidates were not presented for the Scientific Committee for decision.*
- *Additional involvement has not been effective from other stakeholders other than the Oromia and Southern Nations and Nationalities Peoples Regional (SNNPR) States.*

1. Revising Project Programme ..Cont.

Status

- *The MSc students' involvement in both parts of the research as recommended by the Brest Meeting still remains to be feasible during their project work (March – June).*

- *A working document on the Project was also submitted to the Scientific Committee in July.*

2. Assessment and Preliminary Modelling Attempt.

➲Available data has been assessed to be used for flow modelling.

➲A reasonable amount of input data could not be obtained away from the shoulder of the Rift especially the Akaki Catchment.

➲The exercise and modelling attempts were made at the University of Poiters for about a month under the supervision of Prof. Razack.

2. Assessment and Preliminary Modelling Attempt.

➲The exercise and modelling attempts were made at the University of Poiters for about a month under the supervision of Prof. Razack.

➲A steady state flow model calibration for the catchment has been made.

➲The work is in progress.

2. Assessment and Preliminary Modelling Attempt.

➲Generally, the mission was accomplished in that the experience gained was valuable; however, the time allocated was found too short for the job.

➲Recommended to purchase Groundwater-Vistas V5 package with sufficient licenses so that both projects will utilise it.

3. Undertake Laboratory Adsorption Investigation Using IOCS

➲After completing this sample collection part successfully, the researcher went abroad for his PhD.

➲Planned to finalise the experimental work in March when he will be back in Ethiopia.

4. Preparing the works done so far for publication

It was planned to prepare two documents for publication.

- **On the source…..and**
- **Efficiency of IOCS as an alternative low-cost defluoridation techniques in the Rift Valley**

In practice, it was fond appropriate that the first one be divided into two:

- **The current understanding the origin and genesis of fluoride; and defluoridation techniques with reference to Ethiopia (which is under circulation); and**
- **The distribution of fluoride in the Ethiopian Rift (in progress).**

4. Preparing the works done so far for publication

➲The IOCS aspect unfortunately won't be finalised before April, because the main researcher is abroad.

C) Scheduled Activities for the Next 6 Months

1. Submitting the review, distribution; and IOCS works for publication.

2. Finalising the Laboratory Adsorption Investigation Using Iron Oxide Coated Sand:
   - ➲ Determination of physico-chemical characteristics of the collected adsorbents
   - ➲ Testing of fluoride adsorption capacity of the Adsorbents in batch experiments;
   - ➲ Establishing adsorption isotherms and kinetics;
   - ➲ Studying of pH adsorption edge of fluoride-adsorption onto the adsorbents;
   - ➲ Writing up for publication.

C) Scheduled Activities for the Next 6 Months

3. Field work both in the Source and Defluoridation Part Source part:

- **Geochemical and volcanological/mineralogical work in the selected area, Wonji-Metehara area.**

- **In addition to field observations, both water and rock samples will be collected for detailed investigation. It is assumed to take place in March and takes about a month.**

- **This shall involve an MSc student, Dr. Gezahegn Yirgu and Dr. Berhanu Gizaw and possibly some other researchers from the Transect Project.**

C) Scheduled Activities for the Next 6 Months

Defluoridation part:

- **The field work shall also take place in March for short but repeated periods in order to involve an MSc student in an attempt to produce activated alumina locally.**
- **Supervisors Dr. Ghirma and Dr. Alemayehu will be involved.**
- **Aluminium Sulphate Factory as a stakeholder in this will be closely consulted.**

C) Scheduled Activities for the Next 6 Months

Purchasing Related

In order to accomplish what has been planned above, the following need to be purchased:

- Sampling kits and related materials for the Source part of the Project; and
- IOCS minor items and laboratory related materials for the Source part of the Project.

C) Scheduled Activities for the Next 6 Months

4. PhD students applications to the French Embassy to be facilitated in March

- As a long and sustained investigation, we strongly recommend at least two PhD students to be granted from the Fluoride Project.

- Although this fact is known, the positive input of students in other MAWARI projects could only demonstrate the case boldly!

Conclusions and Recommendations

➲ The source part findings made so far will be submitted soon, which is in line with its objectives.

➲Detail work on the selected area is planned to be executed in this phase

➲To pursue our planned activities sustainably and catch up with our schedule, both PhD and MSc students' involvement need to be supported without delay.

Acknowledgements

➲The French Ministry of Foreign Affairs and CIFEG

➲The Geological Survey of Ethiopia and Addis Ababa University

➲The Ministry of Water Resources and Ethiopian Science and Technology Agency

➲The Oromia and SNNPR Regional States Water Development Bureau

Thank you!