Radically Novel Mining Exploration Platform based Upon Sulphur Gas Sensing

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PROJECT ACRONYM: EXPL-ORE
The problem

• The demand for metals worldwide is continuously growing.
• Exploration budgets, however, have been significantly cut, specially during the last five years due to mainly cost concerns.
• In fact, exploration programmes normally call for the deployment of a complex set of geological, geophysical and geochemical surveys, requiring very highly specialized personnel and resource intensive operations (manual sampling, drilling, etc.).

The need

• Mining and mining exploration companies, heavily burdened by these factors, simply cannot grow at the rate demanded by the market.
• The Mining exploration market is rather big: >5,000 M€, with more than 1,500 exploration companies worldwide (which are in fact 1,000 less than in 2012).
• Companies working in exploration, therefore, are fiercely demanding new exploration methods with substantially better technical and cost efficiency.
- Our value proposition: highly **efficient**, radically **novel** platform for the **automated** exploration of **sulphide mineral** ores based upon contactless sensing of characteristic vapours, offering unique cost and throughput advantages for industry.

- In the framework of geological gas sensing, our most direct competitor is the soil-gas technique. (Purely manual, resource intensive).

- Relation to EIT’s interests:

  - Mining exploration & raw materials resource assessment
  - Increase of resource & process efficiency
  - Substitution of critical/toxic materials in products & for optimized performance
  - Mining in challenging environments
  - Recycling and optimisation of End-of-Life products
  - Design of products and services for the circular economy
  - Other
The platform is built of two units:

- 1) An Unmanned Aerial Vehicle (UAV*) for air sampling from ambient atmosphere, retaining the target vapours ($\text{H}_2\text{S}$, $\text{SO}_2$, COS and $\text{CS}_2$) in a special filter, and
- 2) A mobile van for gas analysis equipped with SEADM’s technology: DMA-MS (Differential Mobility Analysis – Mass Spectrometry).

* A unmanned ground vehicle (UGV) can also be used
• Our **patented analysis technology**

(on board of a mobile van)

- Adsorbed Vapours
  - \(\text{H}_2\text{S}, \text{SO}_2, \text{CS}_2\)
- Sampling filter
- Thermal desorption of vapours
- Ionization
- Differential Mobility Analyzer: separation by electrical mobility
- Mass spectrometer: separation by mass and mass fragments

**Results**

Up to five sulphuric gas markers analyzed at trace levels (<< 1 ppt) in less than 1 minute

* A unmanned ground vehicle (UGV) can also be used
• **Quick, automated scan** (< 10 min per hectare)

• **Compelling performance**: 4 km²/week, cost < 5 k€/km², probability of detection > 90%

• **Results readily available** (no complex interpretation needed)

• **Minimum environmental impact**, and:

• **Totally novel concept**: automated vapour sensing for discovery (specially grassroots) plus new insights of mineralization processes.

**Our Booster project**

Validation in real field using manual, terrestrial sampler (TRL 5)

Successfully achieved see “Tests” section

**Prospect**

3-4 year-time development program

(≈2 year for TRL7)

MARKET
Trained dogs used by the GTK of Finland during the period 1965-1994

Very good results achieved but discarded to prohibitive costs.

For evidence and details see reference by Jorma O. Valkama, 2011. (In Finish and English)

Studies by Hale evidence that $\text{H}_2\text{S}$, $\text{COS}$ and $\text{CS}_2$ can potentially be used as markers.
SEADM aims at **manufacturing and delivering the system to the customer**, by a sales price of \(\approx 300 \text{ k€} \), including training, plus an annual maintenance service at 10% of sale price.

**Customers:** companies working in exploration (mining companies and exploration service companies). The customer will be actually the system **user**, whereas the **end-user** of the results obtained will always be the mining companies.

In **Europe** and Middle East → **direct** commercialization; other territories → **allies**.

**Company costs (per item) \(\approx 175 \text{ k€} \).** Manufacturing entails the manual assembly of outsourced components plus internal testing and verification.

**Business prospect figures:**

- **No significant barriers** for adoption of this technology exist: easy-to-use, automated operation, whereas environmental (2006/21/EC) and occupational (89/391/EEC) regulations look favorable, as well that of drones.
- **IPR issues:** all technologies patented or free.
• **Support from SRK Exploration** already obtained.

• Prestigious, leading early adopter → **attract new customers**.

• **New stakeholders** will be sought within **EIT RawMaterials**.

• **Intense labour of dissemination** and product promotion even during the development stage.
Key personnel: complete range of competences for our EXPL-ORE project

Gonzalo Fernandez de la Mora  
**CEO**  
Electrical engineer; more than 30 years professional experience in the private sector, including the big engineering firm SENER, where he worked as Program Manager

Juan Fernandez de la Mora  
**CTO**  
Aeronautics engineer; Yale University Professor, he has been the inventor of the DMA technology. A renowned figure in the field of ion mobility instrumentation.

Mario Amo García  
**Technical Manager**  
Mechanical Engineer; inventor of several SEADM’s proprietary technologies, he currently leads the technical and R&D team

Daoíz Zamora Pérez  
**Project Engineer**  
Automation engineer, his speciality is the development and set up of SEADM equipment for specific applications.

Óscar Fadón Loro  
**Geologist**  
Dr. Fadón will collaborate in the selection of testing sites and assessment of results
Field tests (1/6)

• **Site**

**Otero de Herreros**, Spain: Polymetallic Cu-Zn-Ag-Sn-W skarn deposit linked with shear zones.

Very first field tests accomplished!!
Field tests (2/6)

**Sampling**

- **Air sampling from the atmosphere** (2 cm-height from the ground) at equally spaced positions across a well geologically characterized ground line, with **three mineralization levels** (low, medium, superior)
- **Sampling time** ranging from 3 to 6 minutes*
- **Sulphuric vapors retained** in a Tenax filter subsequently taken for analysis

*This can be seamlessly reduced in further stages of the development*
Results for $\text{CS}_2$

Results for two mass/fragment (91/73 and 91/55) detection channels of the target molecule are shown. Both correlate well with the mineralization level.
• **Results for H$_2$S**

Results for a mass/fragment (109/67) detection channel of the target molecule are shown. The correlation with the mineralization level is well demonstrated.
Results for \( \text{SO}_2 \)

Results for two mass/fragment (139/80 and 151/80) detection channels of the target molecule are shown. 139/80 correlates best.
• The **validation of the platform in the real field with real ores** (TRL5, objective of the project) **has been demonstrated successfully**.
• The results indicate a **clear increment of the signal of all the target substances in areas where the probability of underground emissions is higher**, even though the sampling day was a bit windy.
• In all cases, **maximum signal was achieved for the superior mineralization level area**
• New sampling solutions including **a light drone with pre-programmed flight routines** will be developed in the **next development stage**.
• **Currently looking for funding opportunities**: most immediately, we would like to participate in the [SC5-10-2019-2020](#) H2020 topic (subtopic .a). The system could be developed up to TRL7 (thorough demonstration at real field including the sampling drone).

If you are aware about any consortium going up for the SC5-10-2019-2020 topic where our idea could fit in, please contact: rafael.cuesta@seadm.com

THANK YOU
Thanks for your attention

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