



HAL
open science

SIMS 7F: Enhance radiation protection with insights into processes and origins

David Suhard, Yann Guéguen, Alkiviadis Gourgiotis, Céline Bouvier-Capely

► **To cite this version:**

David Suhard, Yann Guéguen, Alkiviadis Gourgiotis, Céline Bouvier-Capely. SIMS 7F: Enhance radiation protection with insights into processes and origins. 24th International Conference on Secondary Ion Mass Spectrometry, Sep 2024, La Rochelle, France. . irsn-04700856

HAL Id: irsn-04700856

<https://irsn.hal.science/irsn-04700856>

Submitted on 18 Sep 2024

HAL is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.

Copyright

Enhance radiation protection with insights into processes and origins

D. Suhard, Y. Guéguen, A. Gourgiotis, C. Bouvier-Capely

Institut de Radioprotection et de Sûreté Nucléaire (IRSN), PSE-SANTE/SESANE/LRSI, PSE-ENV/SPDR/LT2S, Fontenay-aux-Roses F-92260, France

David.suhard@irsn.fr

Obtaining information on the origin and transfer mechanisms of radionuclides in the environment, as well as their fate in the human body in the event of internal contamination, is an important requirement for enhancing radiation protection. To this end, the CAMECA SIMS 7FE7 instrument is used to characterize the elemental and isotopic distribution in environmental and biological matrices.

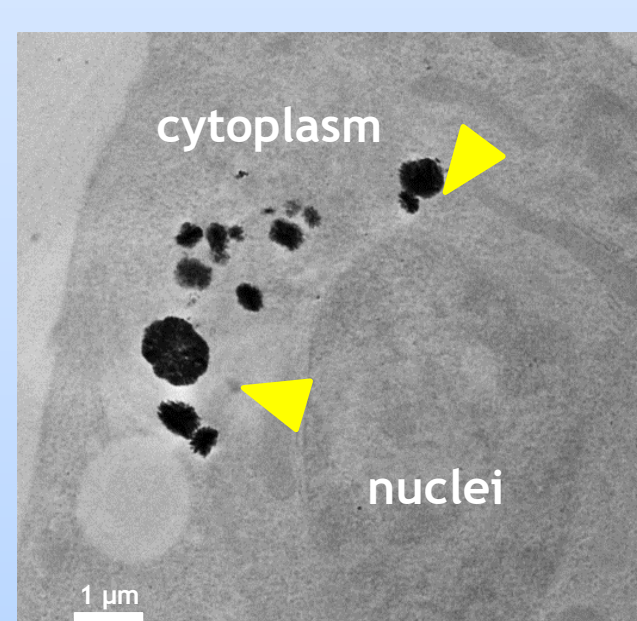
BIOLOGY

- Uranium (heavy metal) has both chemical and radiological toxicities and accumulates preferentially in kidneys (proximal convoluted tubules or PCT) and bones leading nephrotoxicity (after acute exposure)
- Precipitates in the cytoplasm revealed by Transmission Electron Microscopy (TEM) in cells

Objective

Detection and localisation of uranium in various physical forms from tissue to cellular scale

- ➔ Contribute to studies on the incidence of the development of kidney cancer in case of occupational exposure to uranium



Uranium precipitates in cytoplasm (TEM)

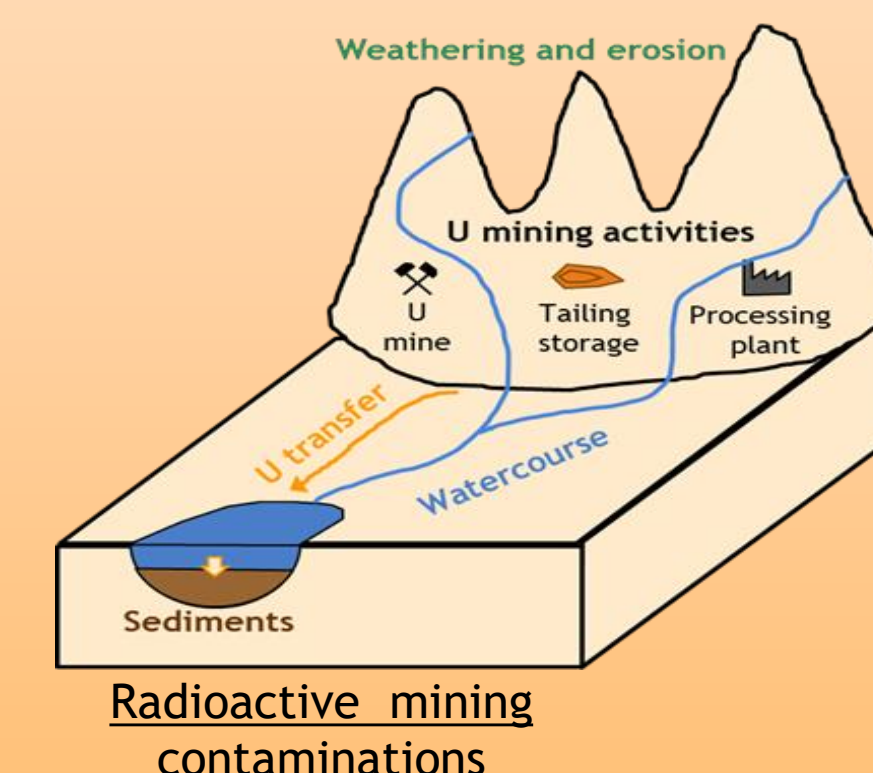
ENVIRONMENT

- Soils and sediments near former uranium mining sites often contain elevated levels of uranium and its decay products compared to the local geochemical background
- High uranium content (and its decay products) in soils and sediments, comparable to mining activities may also result from natural weathering/erosion of the local bedrock

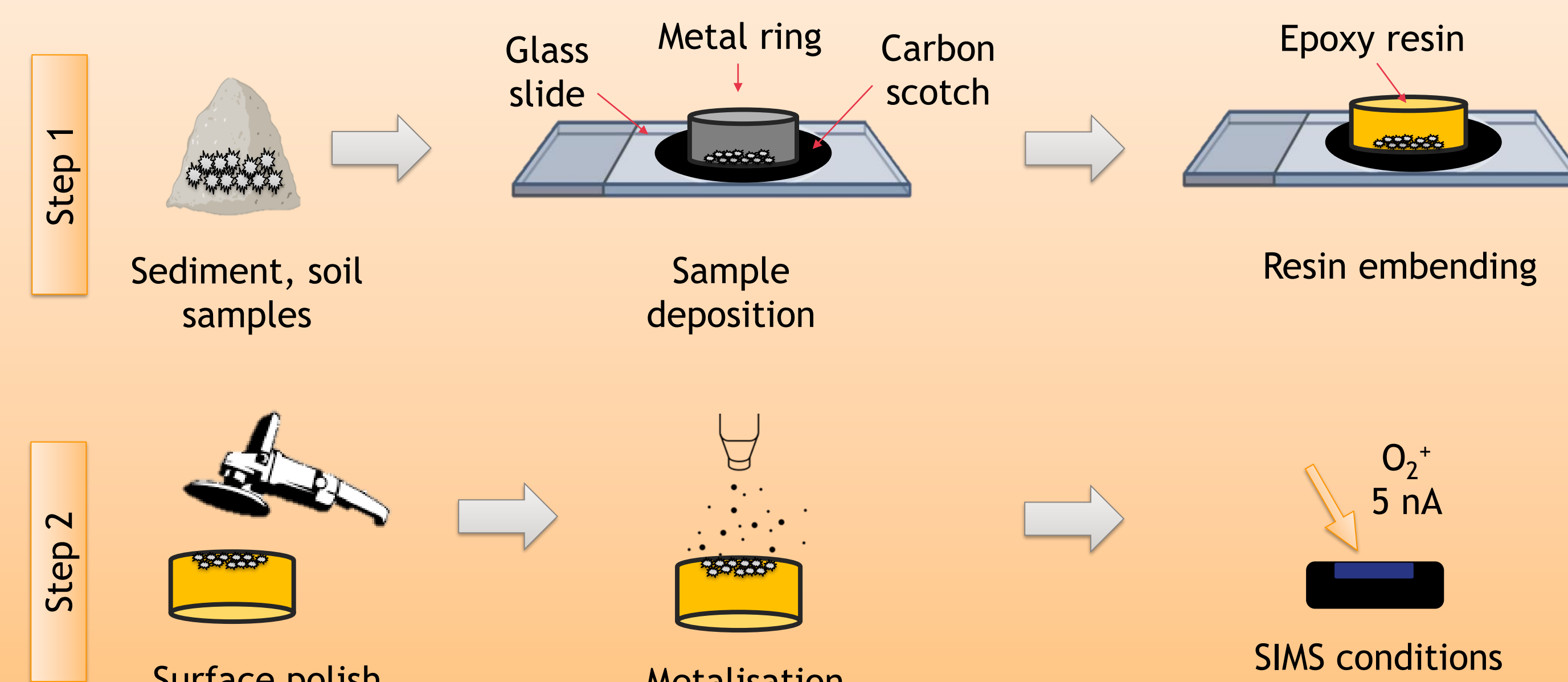
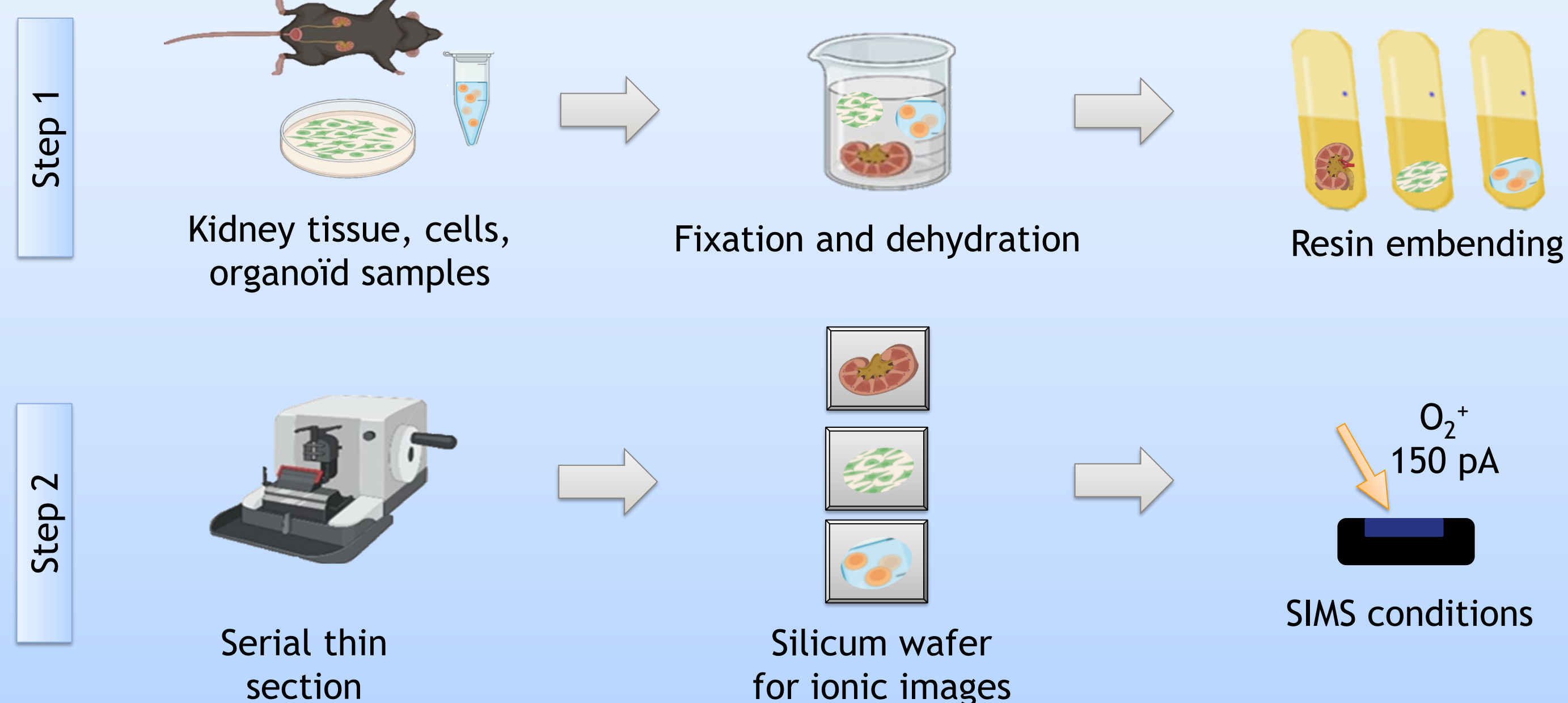
Objective

Identify the sources and transfer/transport mechanisms of radioactive elements

- ➔ Crucial for decision-making, management, and remediation of contaminated areas

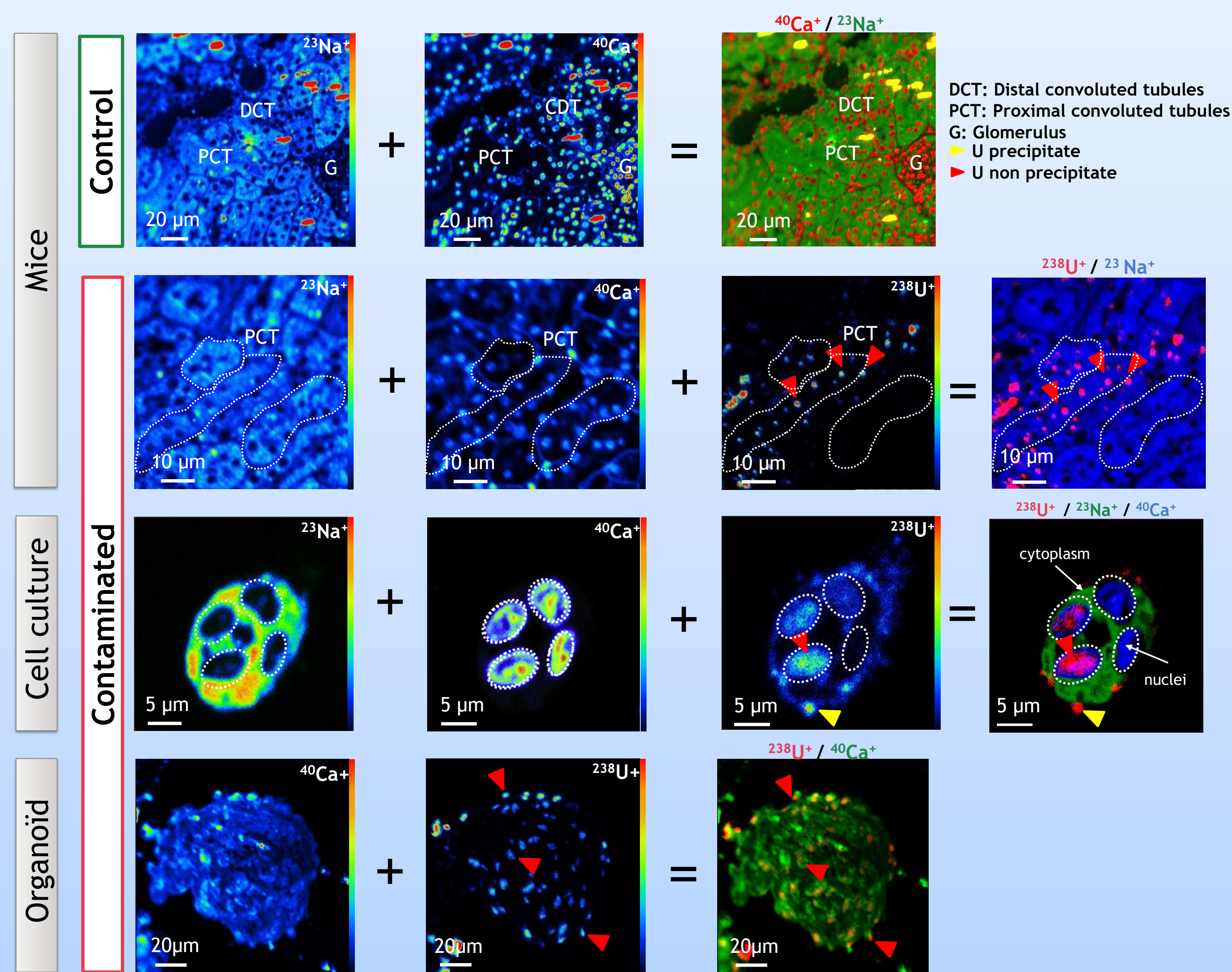


SAMPLES PREPARATION

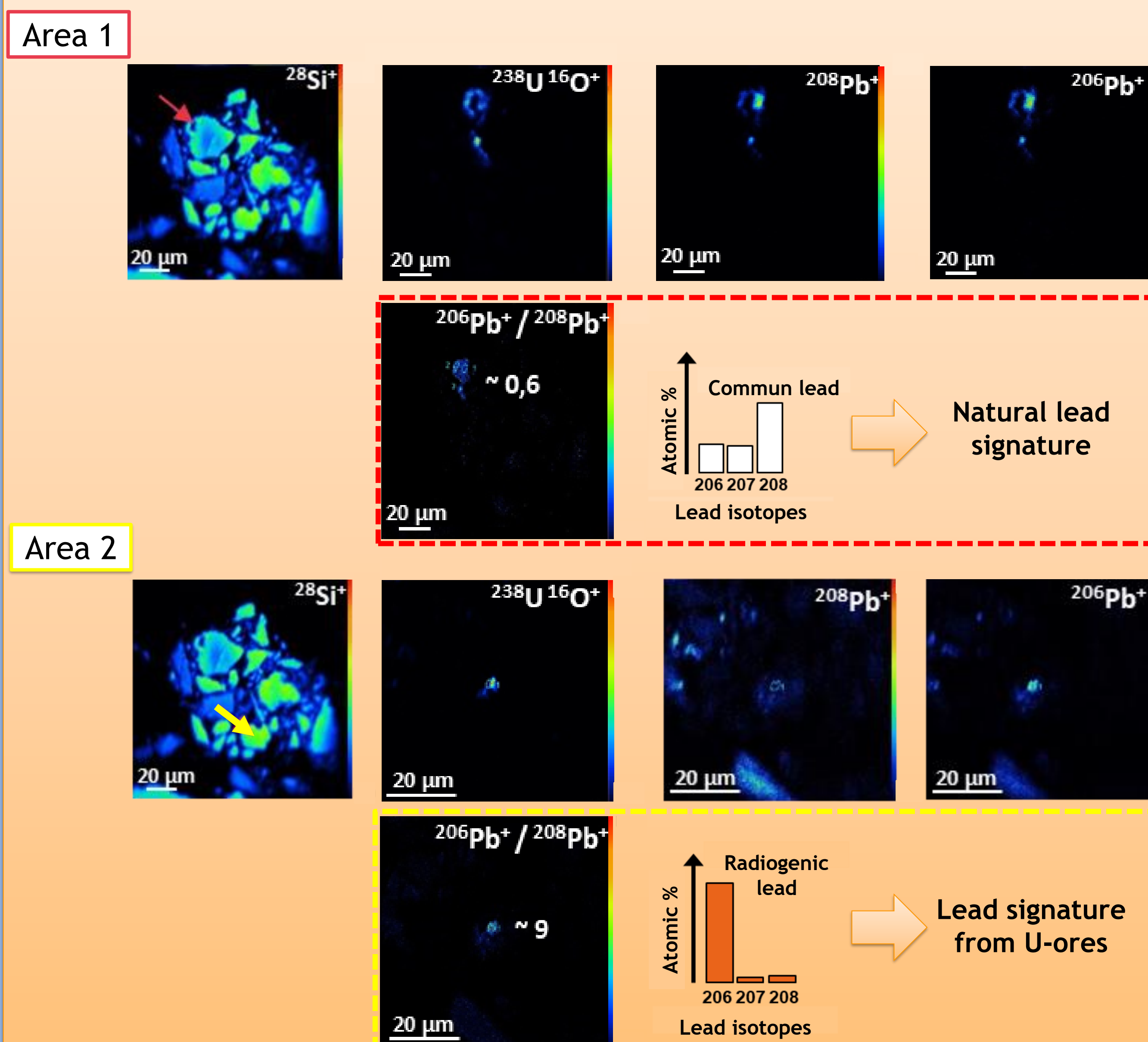


RESULTS

DETECTION AND LOCALISATION OF URANIUM IN KIDNEYS



IDENTIFICATION OF DIFFERENT U-BEARING PHASES IN TWO AREAS OF A SOIL CORE



CONCLUSIONS

- U heterogeneous distribution in rodent renal tissue
- Preferential localisation of U in the PCT nucleus confirmed by studies on cell culture and organoids
- ➔ To provide micro distribution of radionuclides for a better understanding of radionuclides transfer/transport mechanisms

- Confirmation of the presence of a U-rich phase from solid sample
- Identification of two Pb isotope ratios ($^{206}\text{Pb}/^{208}\text{Pb}$)
- ➔ To characterize contamination origin (anthropogenic or natural) based on lead isotope signatures

REFERENCES

Carrière et al. (2008). Transmission electron microscopic and X-ray absorption fine structure spectroscopic investigation of U repartition and speciation after accumulation in renal cells. *Journal of Biological Inorganic Chemistry*

Yann Guéguen et al. (2015). Low-dose uranium enters the HepG2 cell nucleus rapidly and induces cell stress response. *Toxicology in Vitro*

David Suhard et al. (2018). Intracellular uranium distribution: Comparison of cryogenic fixation versus chemical fixation methods for SIMS analysis. *Microscopy research and Technique*

Tingting Geng et al. (2024). Unveiling the origins and transport processes of radioactive pollutants downstream from a former U-mine site using isotopic tracers and U-238 series disequilibrium. *Journal of Hazardous Materials*

Aurélien Beaumais et al. (2022). Combined U-Pb isotopic signatures of U mill tailings from France and Gabon: A new potential tracer to assess their fingerprint on the environment. *Journal of Hazardous Materials*

SIMS 7F is a valuable tool for radiation protection research in the environmental as well as biological fields