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A Mineralomics Approach to Personalized Medicine

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Background

- In humans, two types of mineralisation are observed – hard and **soft tissue mineralisation**
- Soft tissue mineralisation is attributed to **pathological conditions** including cancer, cardiovascular and neurodegenerative diseases
- The **pathological minerals observed are diverse** in their composition, crystallinity, shape and structure
- Different mineral characteristics **can provide previously inaccessible information**

The Mineralomics approach

- To establish a cascade which allows the **holistic analysis of pathological minerals** present in clinical specimens

- A sequence of **advanced materials characterization methods** are employed

The Mineralomics approach

- The dataset obtained has the prospect to impact clinical practice in two ways:

1. On an **individual patient's basis, to improve diagnosis**, prognostic evaluation and personalized intervention planning

2. Yield a **disease specific fingerprint** allowing researchers to develop new preventive and curative measures

The Mineralomics approach

- Breast cancer

- Aortic valve stenosis

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The Mineralomics approach

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The Mineralomics approach – Breast cancer

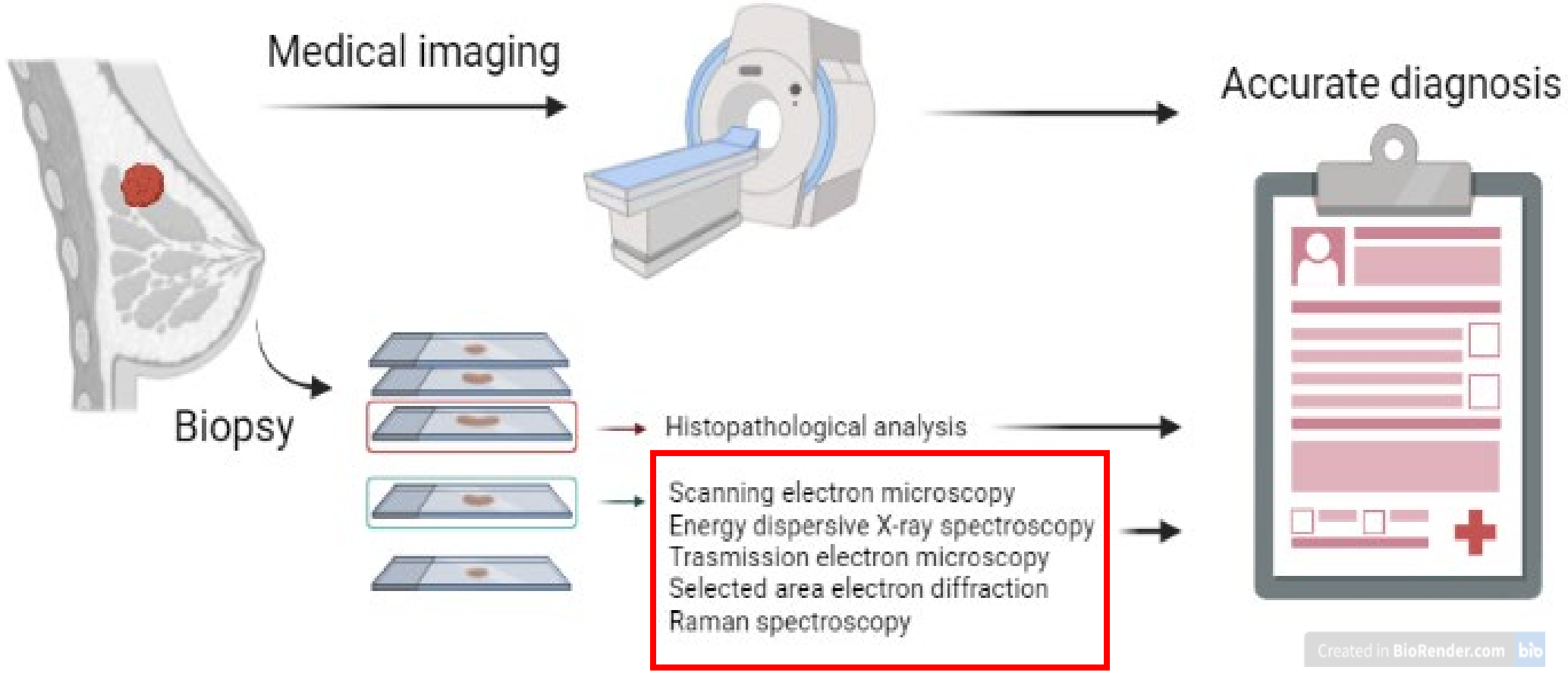
- Breast tissue calcifications are a **common phenomenon** observed on mammograms
- Increasingly recognized to be **an important component of breast diseases**
- **High diagnostic potential** for breast malignancies

The Mineralomics approach – Breast cancer

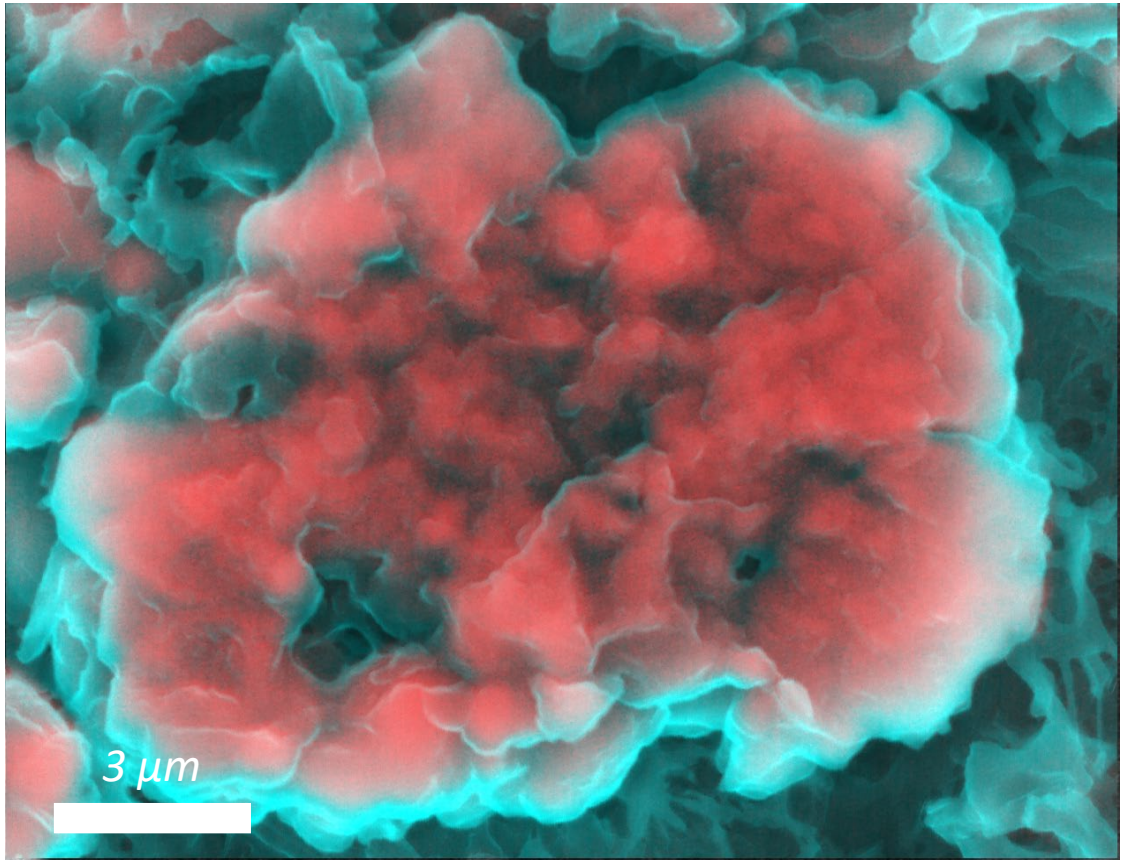
Aim: Investigate the possibility to **gain disease relevant information** through the **characterisation of minerals** found in **healthy, benign and malignant breast tissues**

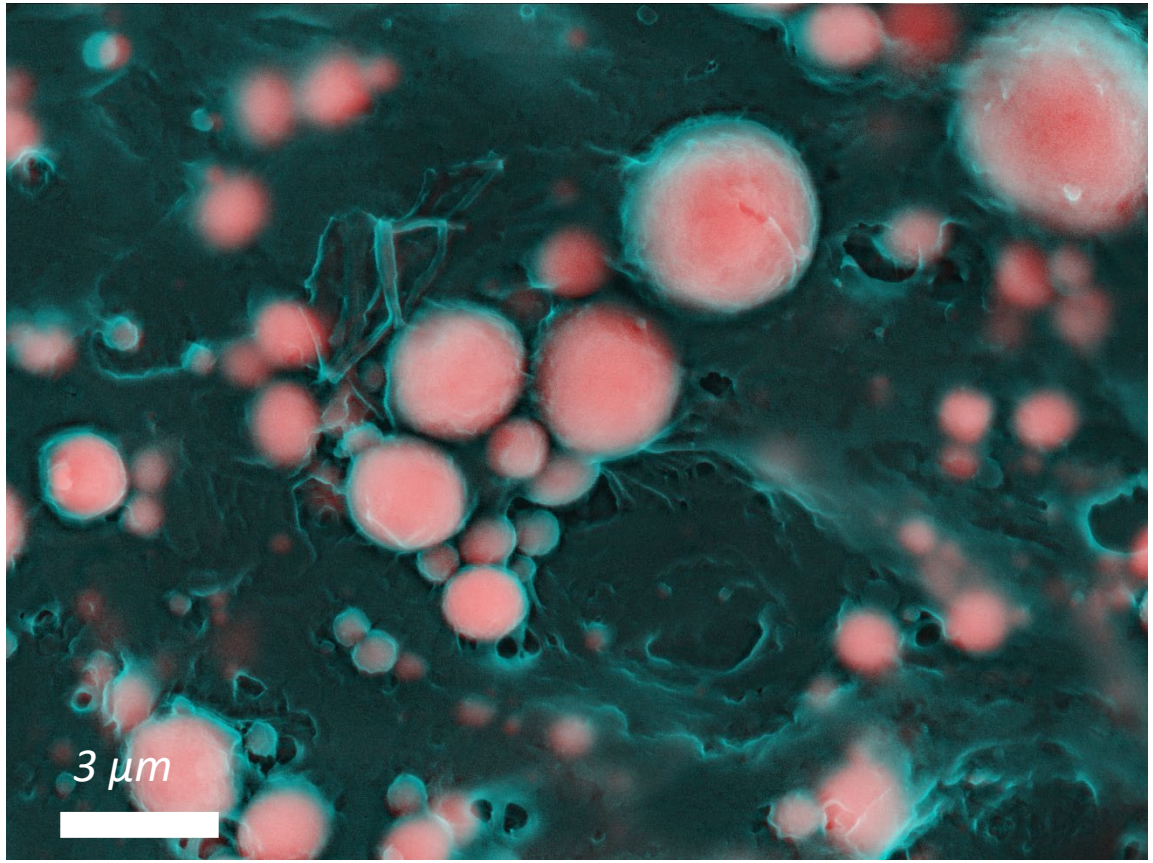
Provide a new diagnostic method independent of the current clinical methods

The Mineralomics approach – Breast cancer



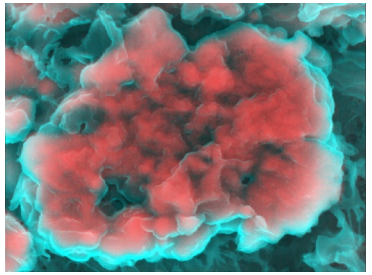
The Mineralomics approach – Breast cancer

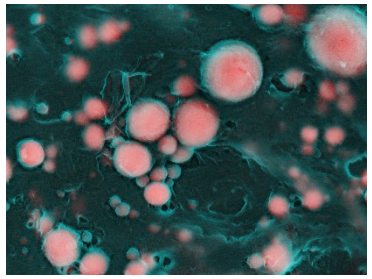


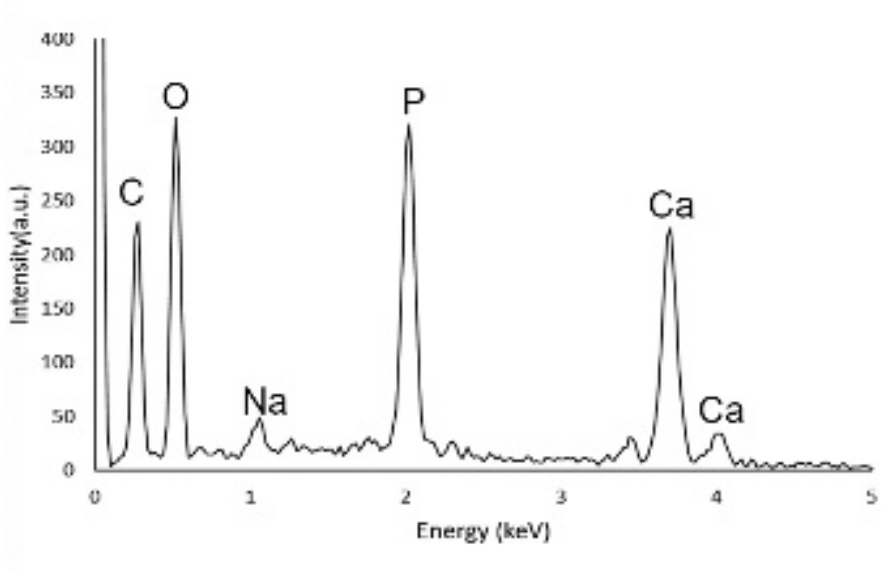


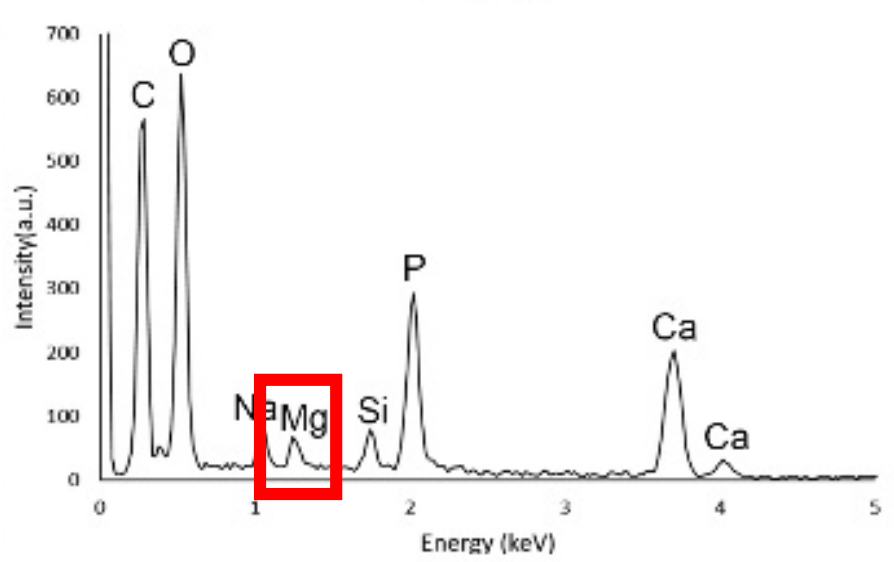
Colour indexing: Red/pink represents inorganic material (mineral) and green/blue organic (tissue).

The Mineralomics approach – Breast cancer

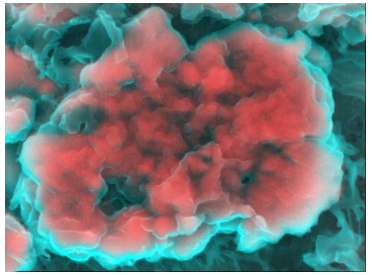


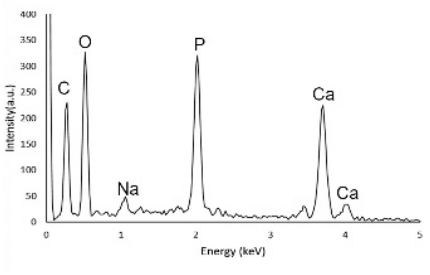


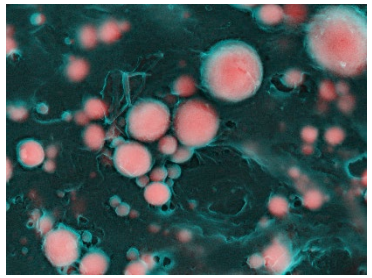


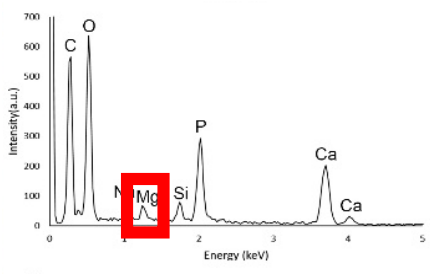


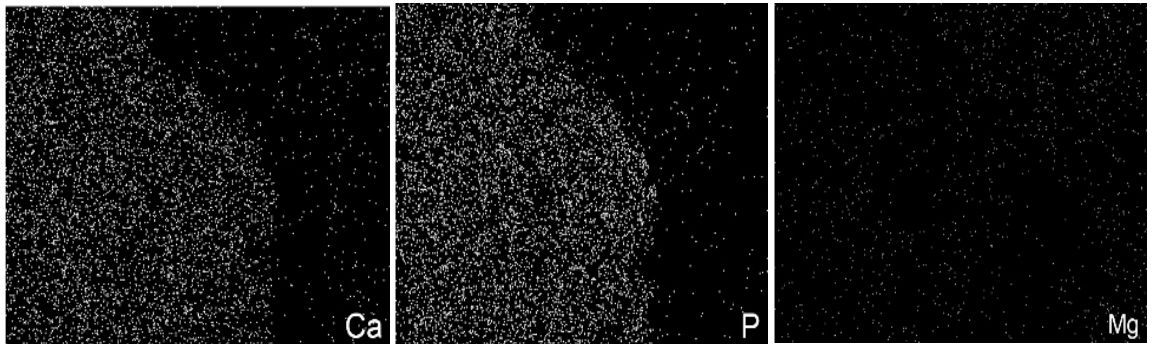
The Mineralomics approach – Breast cancer

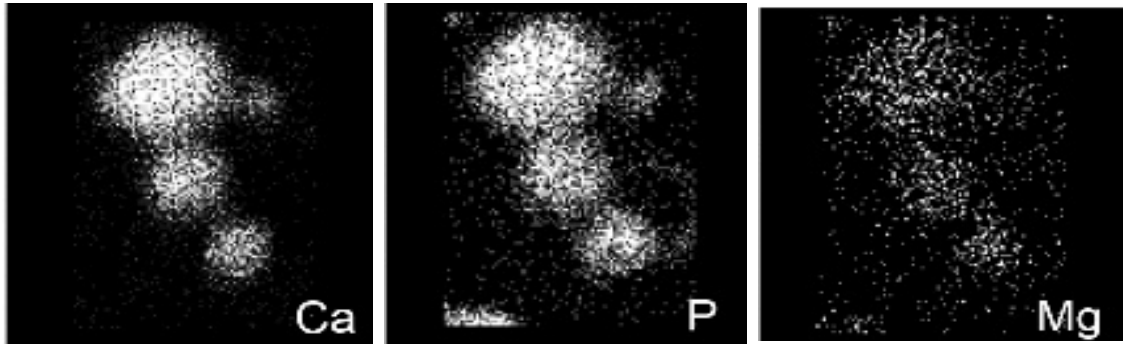




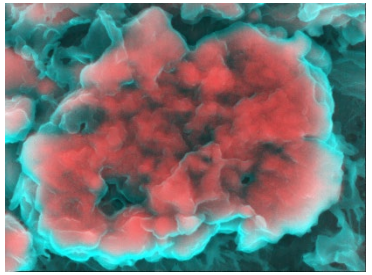


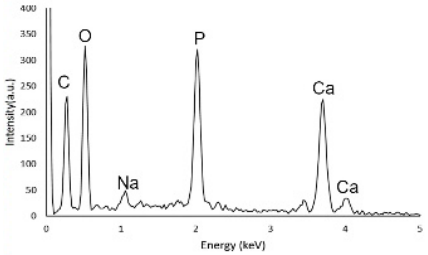


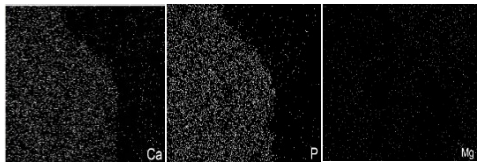


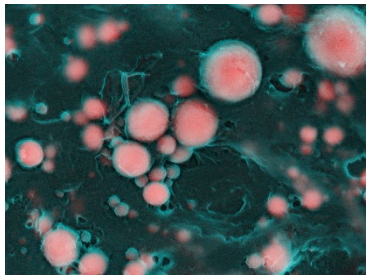


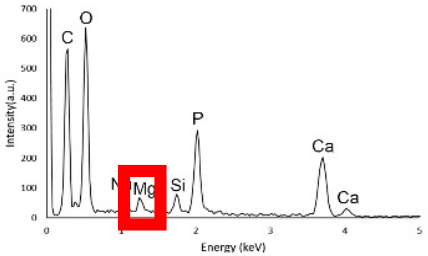
The Mineralomics approach – Breast cancer

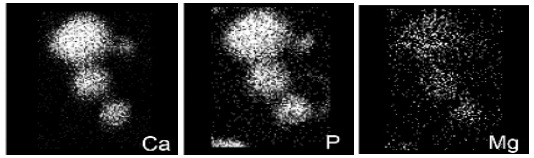


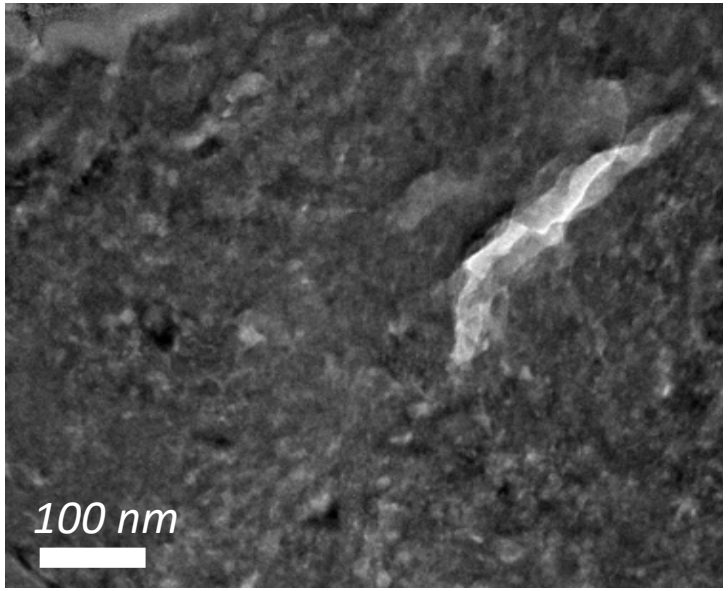


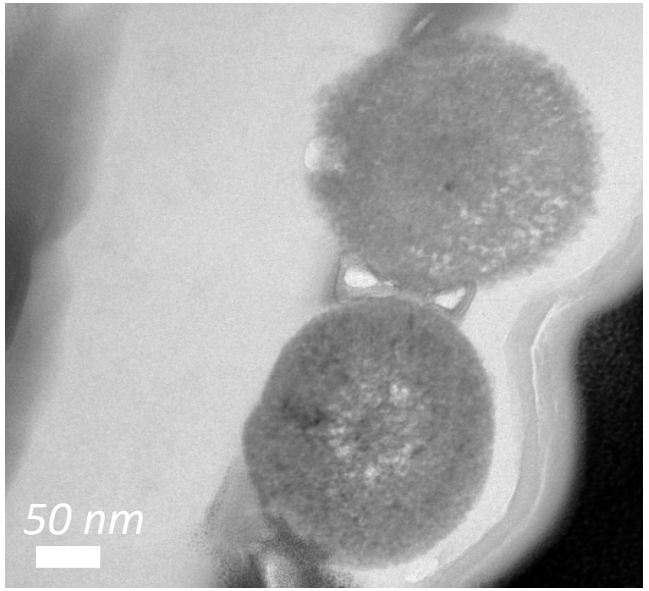




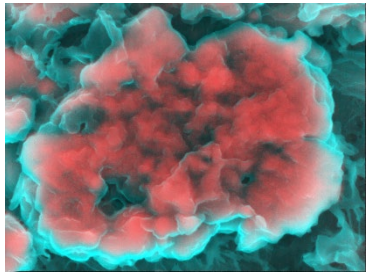


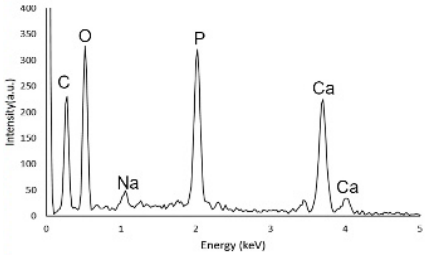


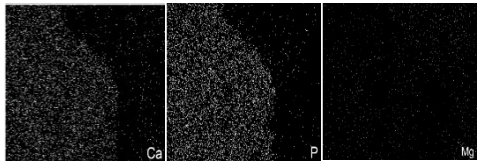


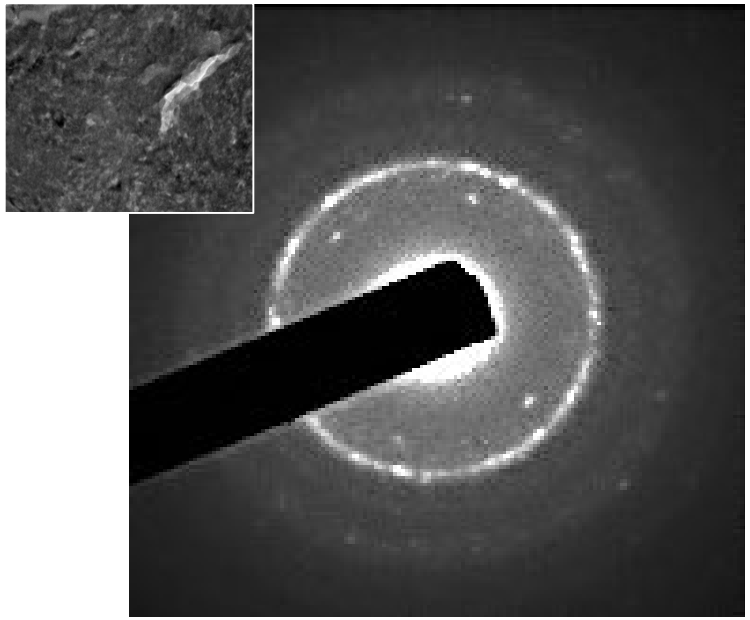


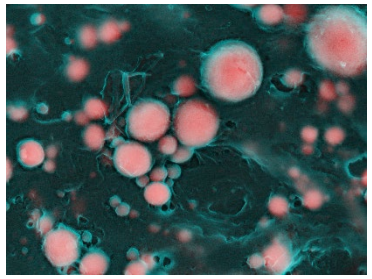
The Mineralomics approach – Breast cancer

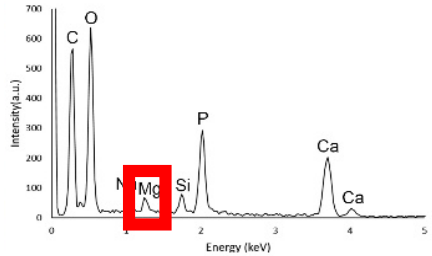


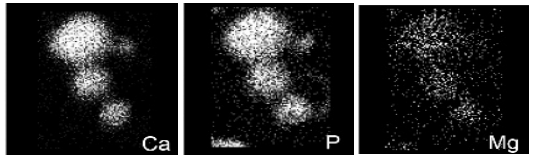


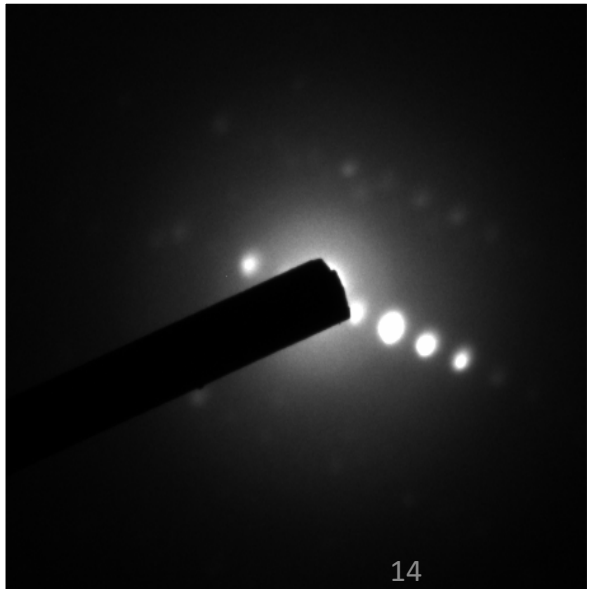




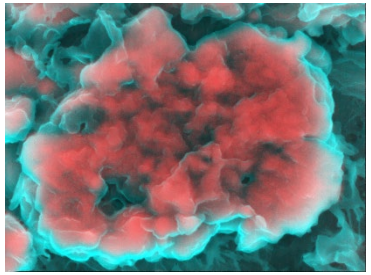


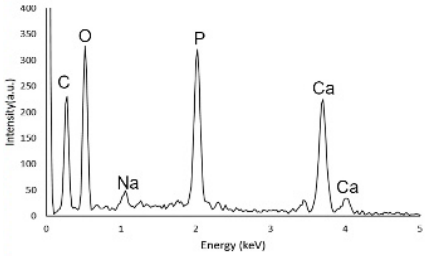


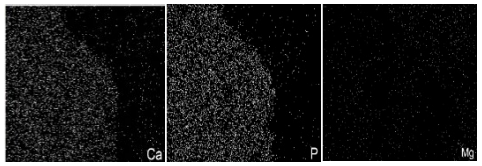


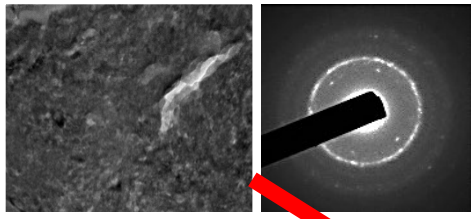


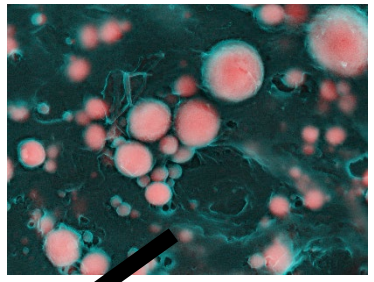
The Mineralomics approach – Breast cancer

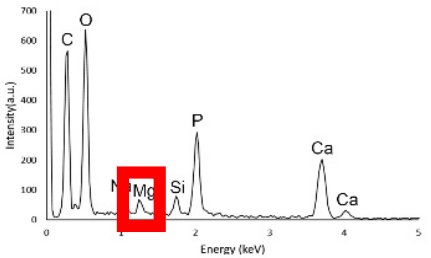


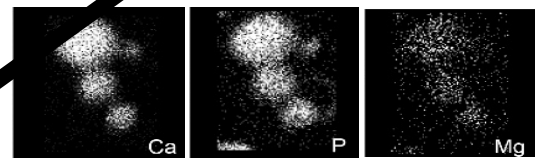


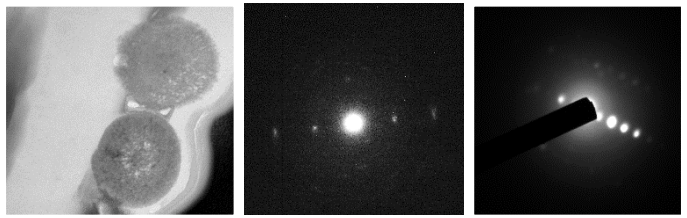


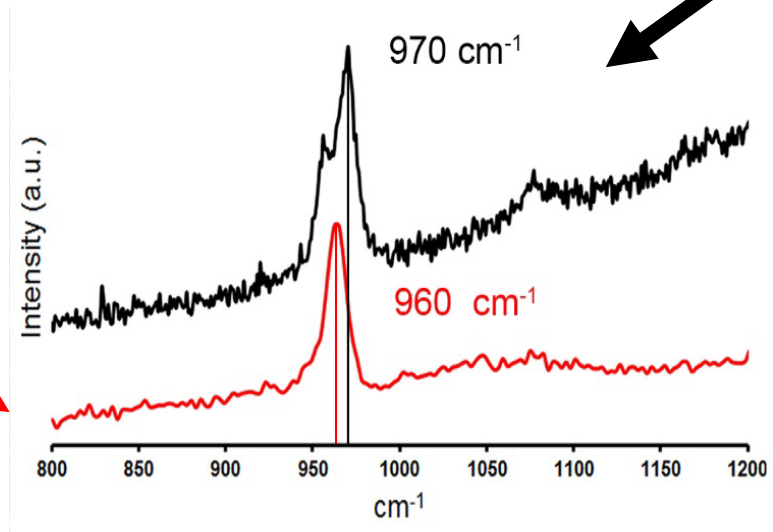




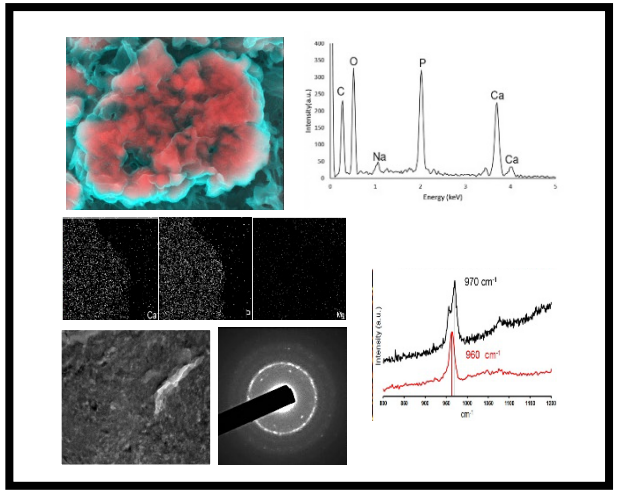


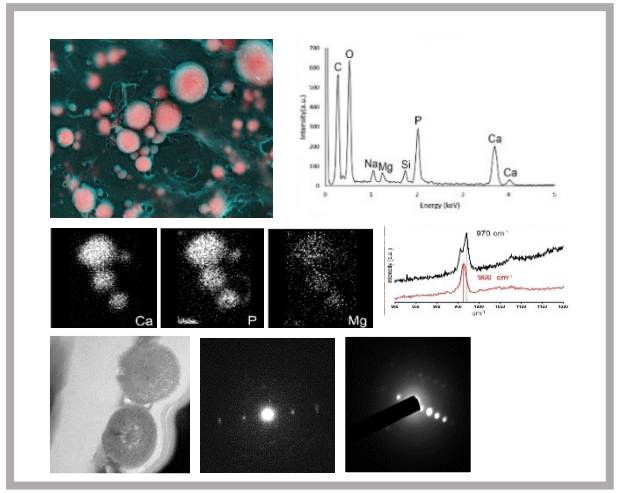


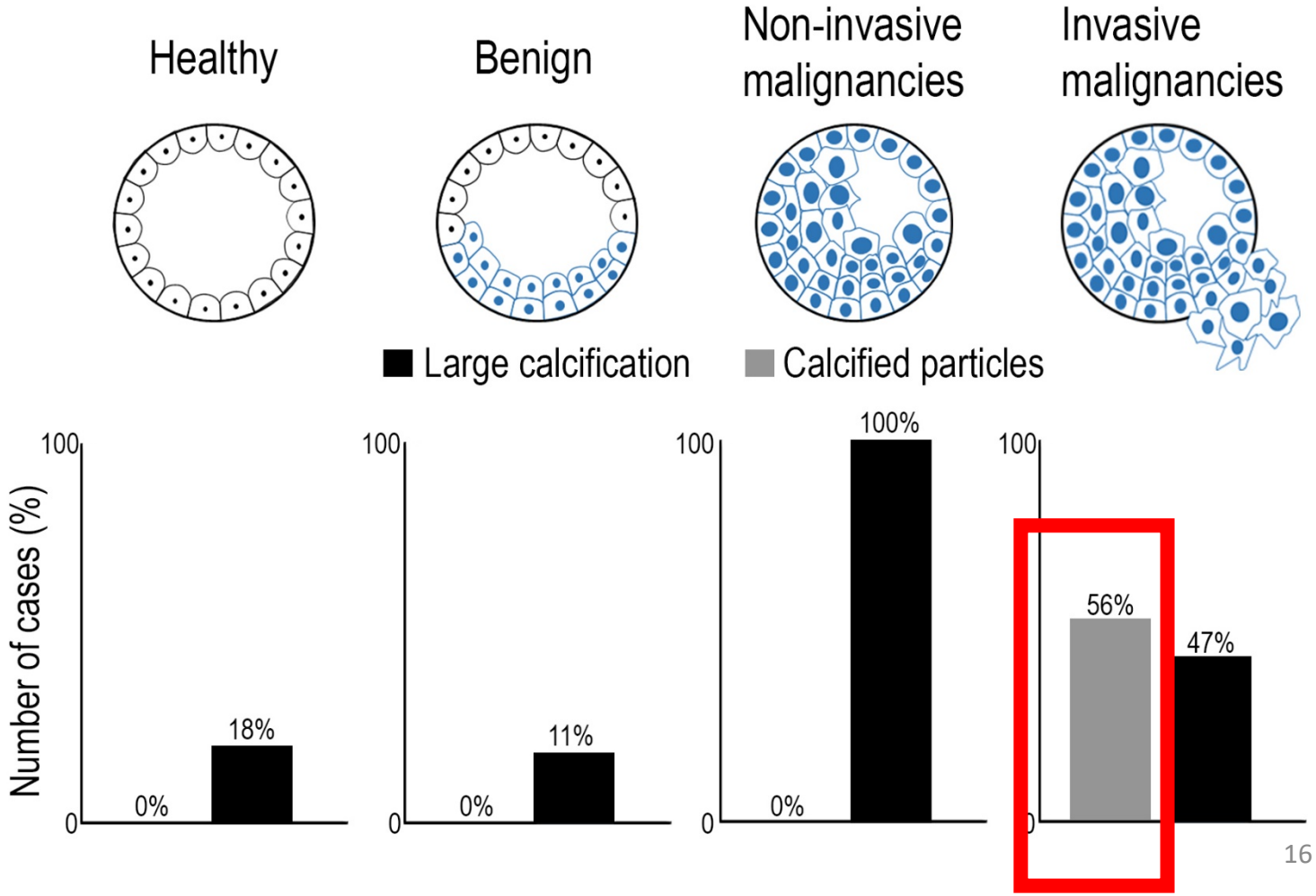




The Mineralomics approach – Breast cancer







The Mineralomics approach – Breast cancer

- **Two distinct types** of breast calcification; large mineral chunks and mineral particles

- **Calcified particle are only observed in invasive malignant tumours**

- Huge diagnostic potential for a bigger clinical study

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The Mineralomics approach

- Breast cancer

- Aortic valve stenosis

The Mineralomics approach – Aortic valve stenosis

- Aortic valve stenosis affects about **12% of the elderly population worldwide**
- The disease manifestation involves **mineralisation of the valvular leaflets** thus in most cases **requires valve replacement**
- **Bioprosthetic valves are widely used** as a replacement which however also present the same limitation as the mineralise

The Mineralomics approach – Aortic valve stenosis

Aim: Provide an **in-depth characterisation of the minerals** observed in **bioprosthetic valves** through a **multiscale approach** in order to gain a **holistic understanding on the mineralisation triggers and processes**

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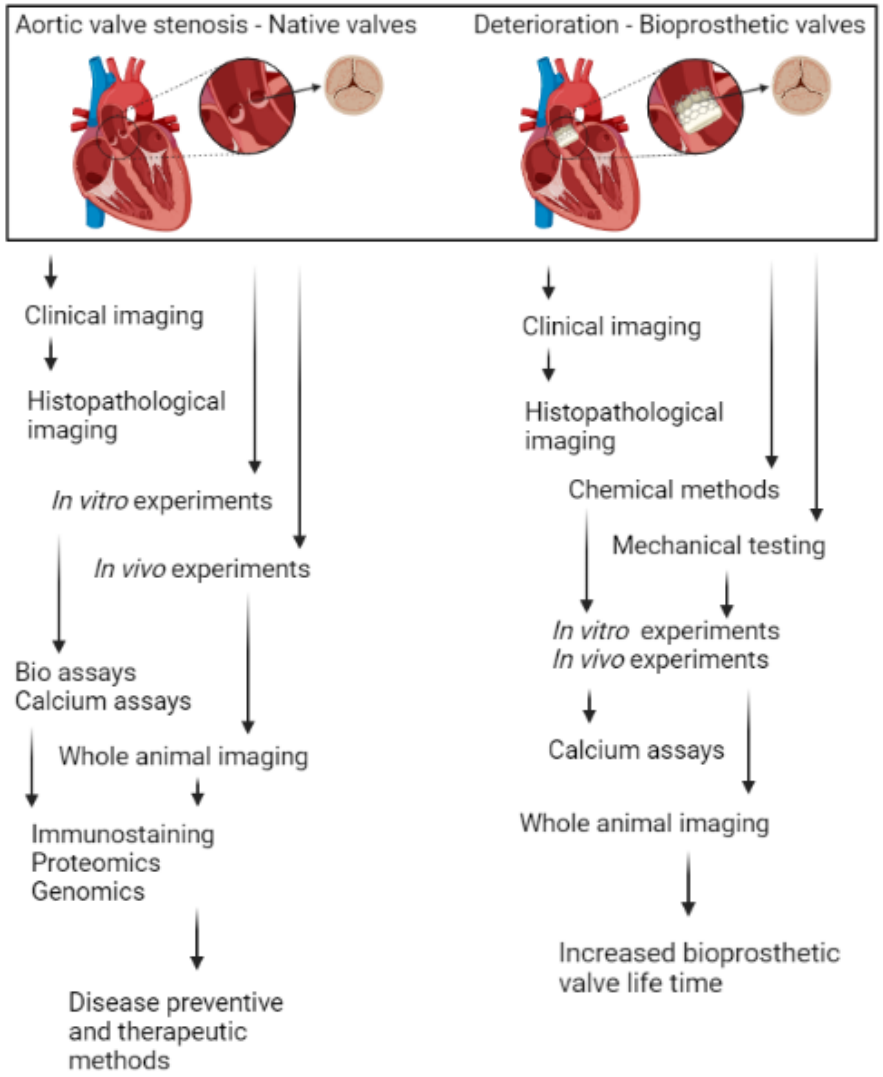
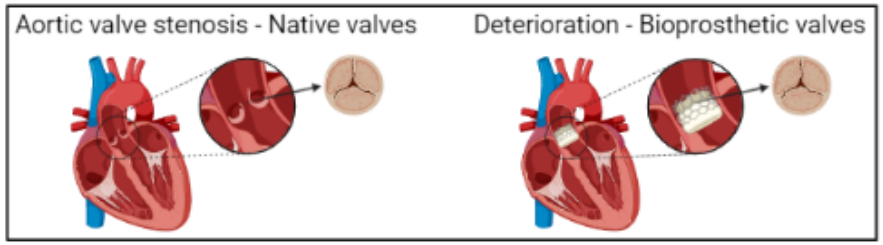
Development of more suitable, long lasting bioprosthetic valves less susceptible to calcification

The Mineralomics approach – Aortic valve stenosis



The Mineralomics approach – Aortic valve stenosis



Clinical imaging
Histopathological imaging
In vitro experiments
In vivo experiments
Bio assays
Calcium assays
Whole animal imaging
Immunostaining
Proteomics
Genomics
Disease preventive and therapeutic methods

Clinical imaging
Histopathological imaging
Chemical methods
Mechanical testing
In vitro experiments
In vivo experiments
Calcium assays
Whole animal imaging
Increased bioprosthetic valve life time

Macroscale analysis:
Hemodynamic analysis
Clinical evaluation

Microscale analysis:
Micro computed tomography (CT)
Spatially resolved small angle x-ray scattering (SAXS)
Histological imaging

Nanoscale analysis:
Scanning electron microscopy
Energy dispersive X-ray spectroscopy

Mineral characterisation across scale

The Mineralomics approach – Aortic valve stenosis

- Better **understanding of calcification** in bioprosthetic valves
- **Comparison of minerals** between bioprosthetic and native valves
- Understand the most dominant **mineralisation processes**
- **Better prosthetic valve design**

Conclusions

The Mineralomics approach can be used as a valuable tool for a range of diseases:

1. As part of the diagnostic workflow
2. In the basic research on pathological mineral characterisation
3. In the development of better preventative and therapeutic methods
4. In the development of better prosthetic tissues

Thank you

Strategic Focus Area
Personalized Health and Related Technologies

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