The Molaoi Zn/Pb/Ag/Ge Deposit

Laconia, Peloponnese, Greece

Meeting the demand for a high-tech and sustainable energy future for Europe.

Christos Skevas – Country Manager

2ND INTERNATIONAL CONFERENCE ON RAW MATERIALS AND CIRCULAR ECONOMY 2023, ATHENS

Hellenic Minerals S.A.

MOLAOI….an important project for Europe

- A critical metal, germanium (Ge), has been discovered at Molaoi.
- The EU Environmental Agency includes germanium in the top 20 critical metals, owing to risk of supply shortages.
- The weighted average grade of 51 samples collected during re-analysis of drill core is 51 g/t Ge, with a peak value of 197 g/t Ge.
- Commercially saleable grades of zinc (57% Zn), silver (856 g/t Ag), lead (63.6% Pb), germanium (117 g/t Ge), copper (2.62% Cu) and gold (0.52 g/t Au) are achieved at Molaoi.
- Germanium reports to the zinc concentrate with a commercially competitive grade of 117 g/t Ge and is expected to be recovered as part of the zinc concentrate. This is expected to be a valuable credit in the concentrate.

GERMANIUM….a brief history

Element 32

1869

Dmitri Mendeleev predicted the existence of a new element from its position on the periodic table. It was believed to be something midway between silica and tin.

1886

The element was isolated from the silver sulfide, argyrodite and described by Clemens Winkler. He named the new element germanium, after his native country, Germany.

GERMANIUM

2018

The U.S. Department of the Interior published a list of 35 critical minerals, including germanium.

The EU lacks domestic production of most Critical Raw Materials (CRM's), resulting in it becoming highly dependent on other countries for high-tech components and assemblies. It is of strategic importance for the EU to reduce its CRM dependency on other countries and to safeguard future supply chain. It is a high priority for the EU to build capability to process CRM's.

A European strategy for critical raw materials (2012).
European Parliament resolution of 24 November 2021 on a European strategy for critical raw materials (2021/2011(INI))

2020

The EU deemed several minerals to have a high supply risk, which became defined as Critical Raw Materials (CRMs). This list included germanium.

2021

Calls were made for the European Commission, the European Investment Bank, and other EU institutions to provide technical and financial support for long-term CRM investment projects. Such calls include sharing risks in the mining sector, as well as promoting and supporting investments in research on CRM sourcing, processing and refining within Europe.

- Germanium does not exist as a native metal but occurs in the crystal lattice of ore minerals.
- Germanium is mostly produced as a by-product of zinc smelting.
- The average germanium content of the Earth's crust is between 1.0 - 1.7 ppm Ge.
- Germanium reports to a flotation concentrate with an average grade of 117 ppm Ge at Molaoi.

A natural semiconductor of electricity

Transparent to part of the infrared spectrum. Normal glass is opaque to the infrared spectrum.

It is a glass-former, capable of forming large 3D networks of germanium-oxygen bonds into sheets.

It has a high refractive index. The refractive index determines how much the path of a light beam is bent or refracted.

Low chromatic dispersion allows for high data-carrying capacity of an optical fiber.

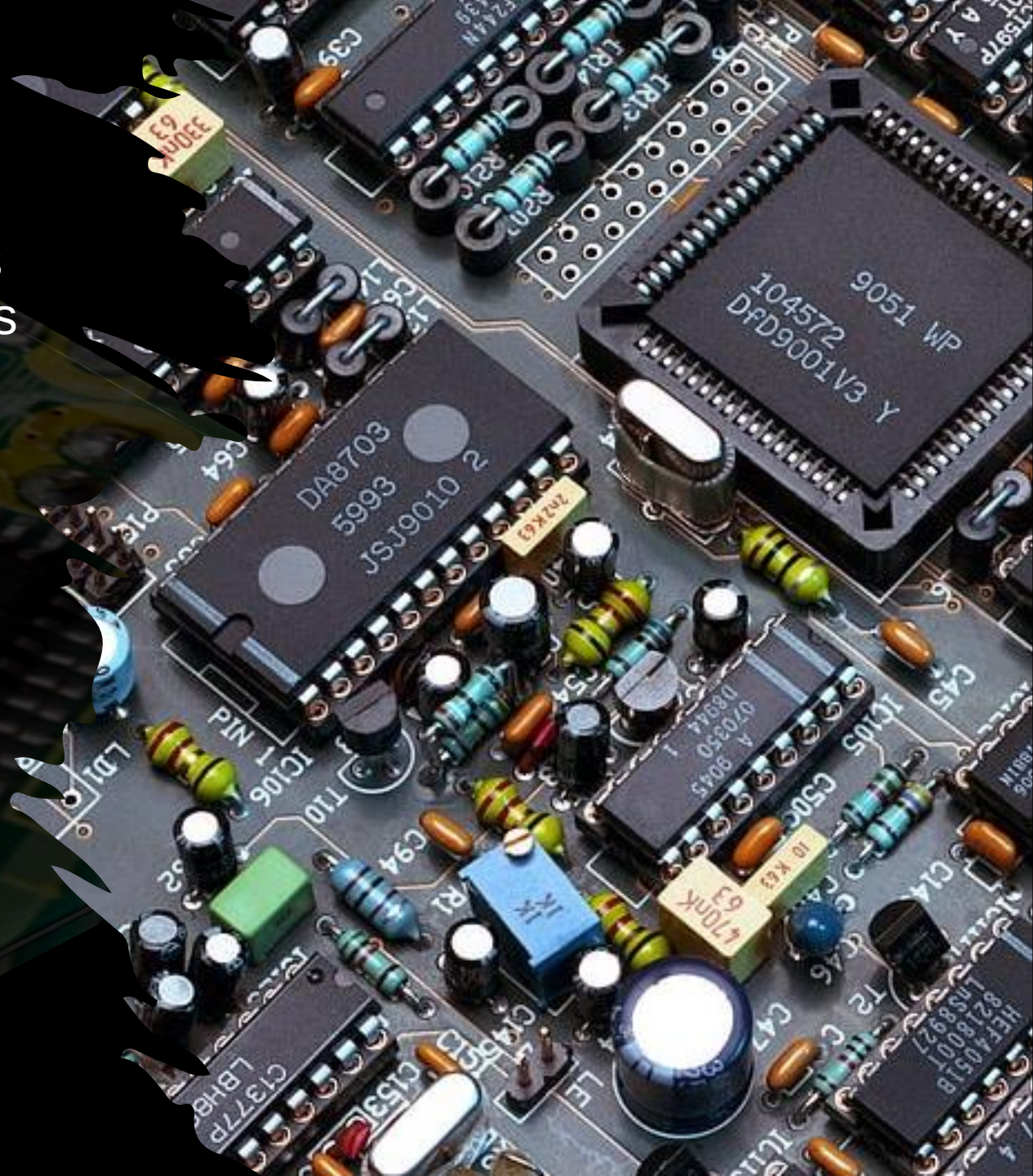
Low chromatic dispersion also allows for an increased distance between repeaters in a communication link.

Electronics

- Silicon-germanium enables manufacturers to produce smaller electronic chips, with less electronic noise interference from the chip itself.

- Germanium-based chips are more energy efficient than traditional silicon-based chips and extend the life of battery-operated electronics.

- Other benefits include being more stable over a wider range of temperatures and operation at ultrahigh frequencies.



Advanced Driver Assistance Systems (ADAS)

Integrated into all modern vehicles for essential safety features, including:

- Forward-looking infrared (FLIR) devices form images by sensing the thermal contrast between objects and background. They can work in complete darkness and are not affected by smoke or fog.
- parking assistance
- blind spot detection (BSD)
- lane change assist (LCA)
- reverse parking sensors
- “Nightdriver”, night-vision system manufactured by Raytheon allows drivers to see up to 5 times farther.

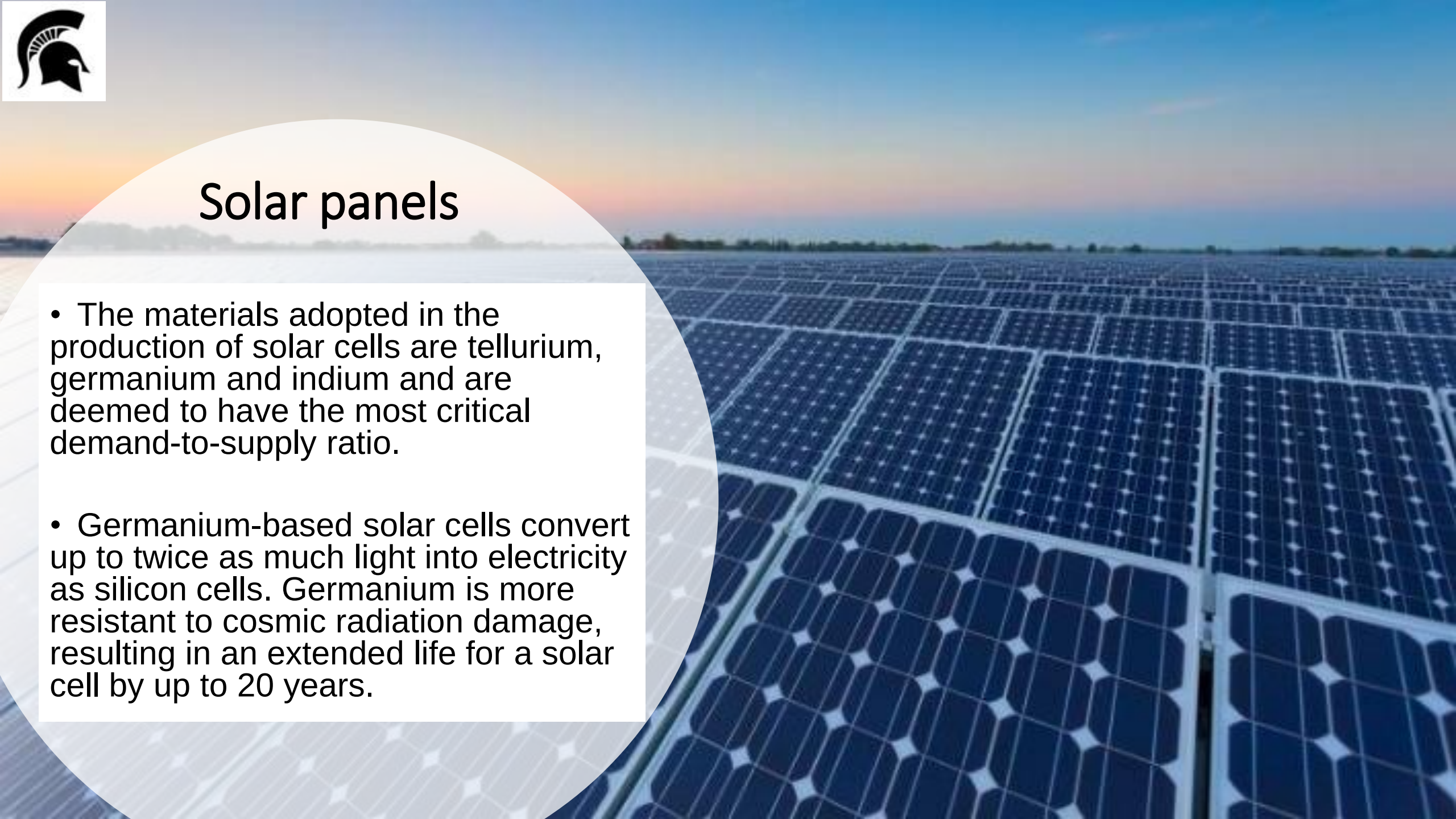
Plastics

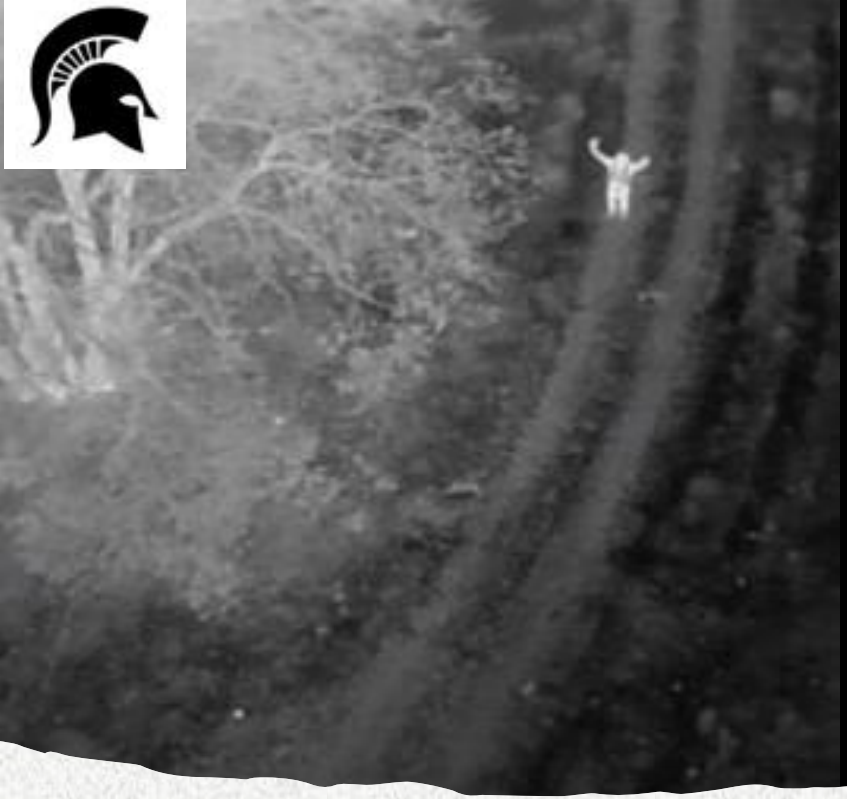
- Germanium is a catalyst in the production of polyethylene terephthalate (PET) plastic. Used in bottles, food packaging, bakery products, water and soda bottles, peanut butter and condiment jars, frozen food packaging, cosmetics, as well as plastics for the storage of chemicals and household cleaners.

Solar panels

- The materials adopted in the production of solar cells are tellurium, germanium and indium and are deemed to have the most critical demand-to-supply ratio.

- Germanium-based solar cells convert up to twice as much light into electricity as silicon cells. Germanium is more resistant to cosmic radiation damage, resulting in an extended life for a solar cell by up to 20 years.



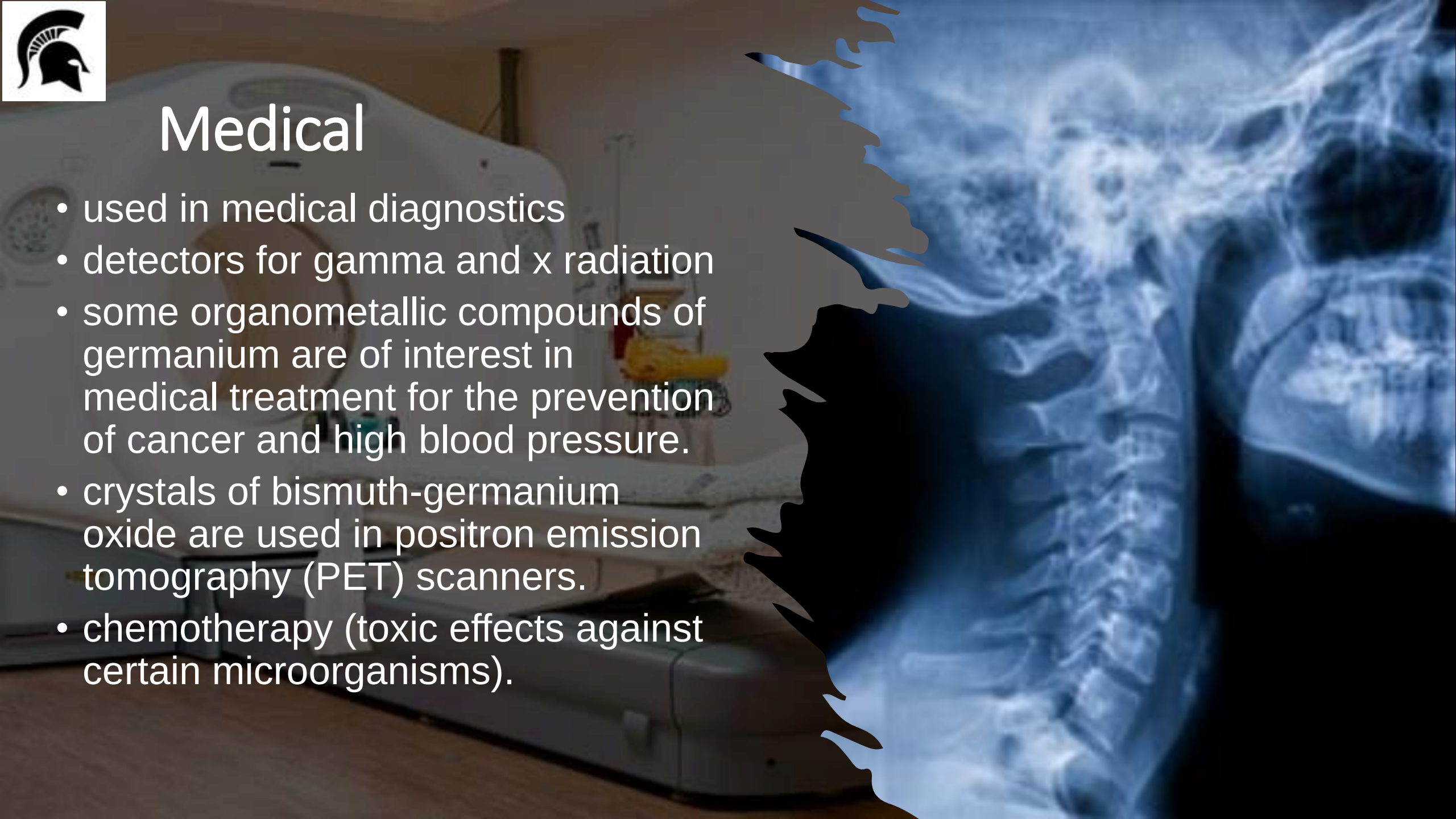


Safety and security

- infrared night-vision and surveillance
- locating lost hikers in wilderness areas
- monitoring rock surface temperatures in mines
- detecting faults in structural materials
- personnel detection equipment in poor visibility environments
- used by fire departments to improve thermal-imaging systems to detect endangered individuals, hot spots, and team members in smoky environments.

Medical

- used in medical diagnostics
- detectors for gamma and x radiation
- some organometallic compounds of germanium are of interest in medical treatment for the prevention of cancer and high blood pressure.
- crystals of bismuth-germanium oxide are used in positron emission tomography (PET) scanners.
- chemotherapy (toxic effects against certain microorganisms).

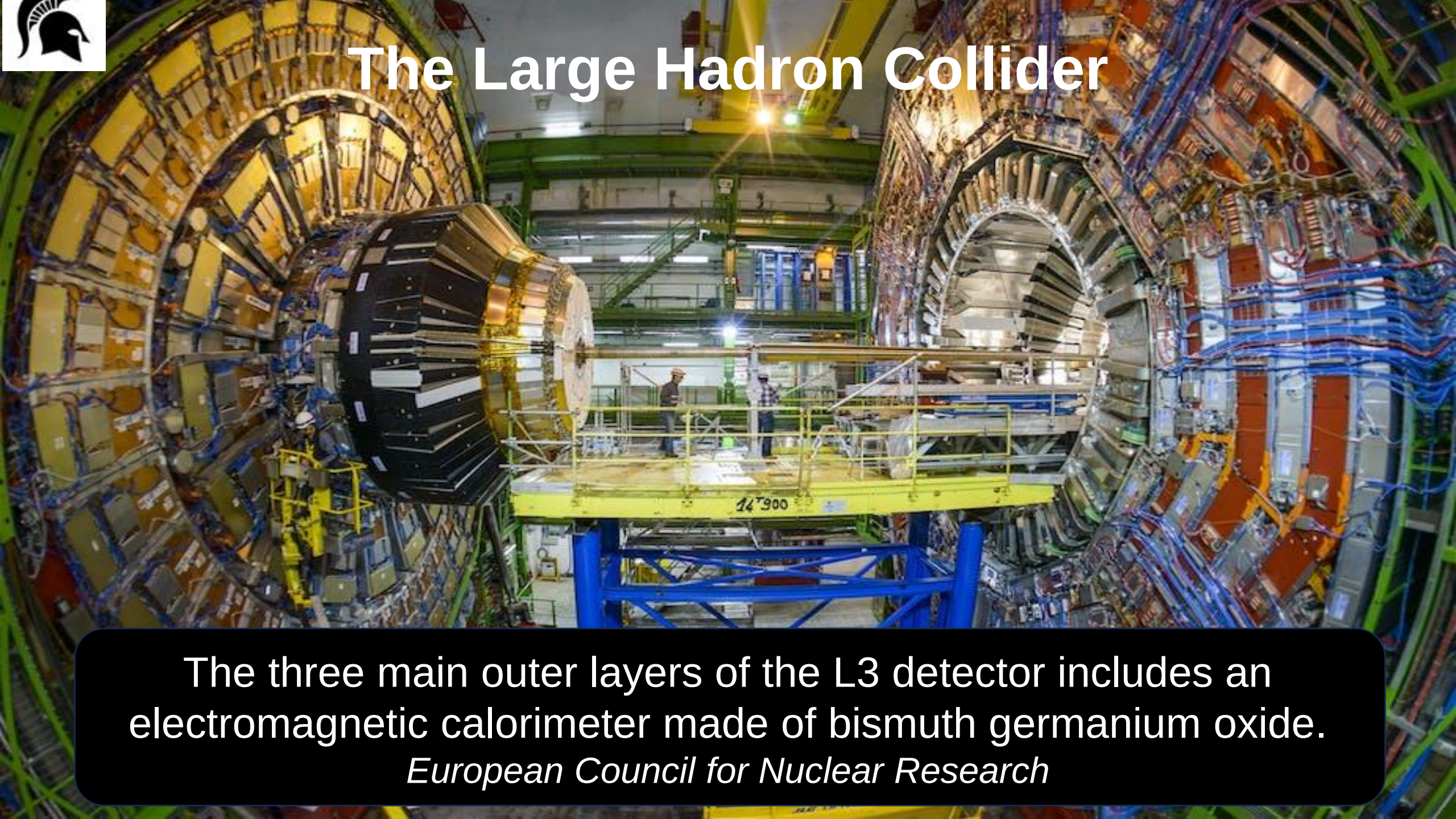


- weapon-sighting applications
- Infrared night vision goggles and binoculars
- surveillance cameras
- infrared heat-seeking missile guidance
- global positioning systems (GPS).

Miscellaneous

- Germanium dioxide has been an ingredient of the glass used in wide-angle camera lens
- Germanium resistance thermometers are used for precision temperature measurement

The Large Hadron Collider



The three main outer layers of the L3 detector includes an electromagnetic calorimeter made of bismuth germanium oxide.

European Council for Nuclear Research

The search for Dark Matter

GALATEA is a test-facility, designed to study the properties of Germanium detectors in space for the search for dark matter.

The GALATEA test-facility (2015).

Germanium for Europe

- Germanium is a by-product of zinc sulphide processing.
- 80% of the world's germanium oxide is produced in China.
- Under industry-standard leaching conditions, only approximately 70% of germanium is recovered.
- Germanium is known to have a strong affinity to silica. During the sulphuric acid leach process, any silica present will tend to polymerize to form a silica gel.
- Where both germanium and silica are present, germanium is often adsorbed into the silica gel and becomes locked inside the silica gel, rendering the germanium insoluble.
- Hellenic will commence research to improve the recovery of germanium, with the aim to provide Europe with its own domestic supply of germanium oxide.

OXIDISING ROASTING → **LEACHING** → **CALCINATION** → **ELECTROWINNING**

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