**Written evidence submitted by Dr Jose Gonzalez-Rodriguez (MIN0018)**

Dear sir or madam,

I am submitting my evidence to the Foreign Affairs Committee inquiry into critical minerals.

My name is Dr Jose Gonzalez-Rodriguez, Associate Professor in Analytical Chemistry of the University of Lincoln and founder of the venture company Environmental Selective Extractions (ESE), a specialist research, design and manufacturing company dedicated to recycling and extraction of valuable/hazardous compounds. I am submitting this evidence as an individual.

I have an area of specialism around recovery of critical materials using novel and traditional technologies. I have developed two patent applications for recycling compounds of interest for industrial applications and published 83 papers and 40 communications in different areas of analytical chemistry and material science.

I learned of the call for evidence for this committee through the UK Parliament Committees website.

Having read the terms of reference, I would like to comment on some of the aspects covered in the remit of the enquiry. I have a special interest in the use of new technologies in recycling and these may have the key to some solutions to the questions posed in this enquiry.

1. **Summary of conclusions,**
   - 1.1. Increase in recycling for critical materials within the UK must become a priority.
   - 1.2. There is an urgent need to perform an analytical survey of industrial residues with identification of matrices, elements, concentrations and seasonal variations to assess availability of critical materials when supply is greatly threatened.
   - 1.3. An in-depth study on the suitability of novel technologies for the extraction of low-yield sources of critical metals needs to be performed.
   - 1.4. Negotiations and agreements on accessing and securing trading of critical minerals with continental Europe need to be explored to maintain a minimum supply in case of need.
   - 1.5. In the long-term, the technological substitution of those materials that create a vulnerability in our supply chain should be aimed.
   - 1.6. The UK needs to implement a wider strategy to stockpile and preserve key critical materials, including stricter controls on exports of waste containing substantial concentrations of these materials.

1.7. A coordinated action with other allied countries, establishing political and security agreements with national agencies and industrial corporations, is needed to cover the whole supply chain of certain products.

1.8. The UK needs to influence an international political move to establish stricter measures to protect existing commercial agreements and strengthen sanctions against breaches of contractual obligations.

2. **Opportunities for the diversification of the UK's critical minerals supply chains.**

It is well-known that the technology sector highly depends on materials with a limited supply and often controlled by a handful of countries. All great powers in the planet compete in a global struggle to achieve a secure supply of certain elements. Some of these materials have a great impact in defence and the development of renewable energy technologies. Limited availability of some of them can compromise scientific and technological advances in key areas, hindering our technological progress, energy independence or security.

Recycling and search for industrial, natural and alternative sources within the UK must become a priority. In this sense the UK's Department for Business, Energy and Industrial Strategy (BEIS) has established a plan and by March 2023 a planned survey of critical minerals will offer a clearer picture of what natural resources are available to us. The establishment of the UK's Critical Minerals Intelligence Centre (CMIC) in 2022 and delivered by the British Geological Survey (BGS) is excellent news and a step in the right direction. The Centre has already produced valuable reports and information to enhance the UK's resilience to such shortages. However, there is still a gap in the policy paper from Government [1], as this does not go deep enough in the identification of industrial and non-industrial sources of these materials in a wider context, including solid or liquid waste effluents from a diversified list of industries and household waste. An analytical survey of industrial residues with identification of elements, concentrations and seasonal variations could prove valuable in a scenario when supply is greatly threatened. In this case, a sustainable supply, even at low scale, can prove valuable if trading of these metals become compromised by an unstable political situation. This point raised by the UK CMIC in their Commission Report OR/22/034 [2] is, in my opinion, a key point that needs to be developed further. The literal quote from this report indicates that 'until the flows and compositions of these materials are adequately quantified it is impossible to understand how they can contribute to supply'.

Together with this list and the analytical survey mentioned above, an in-depth study on the suitability of traditional technologies for the extraction of low-yield sources of metals (expected to be the case for most unusual sources) needs to be implemented. A variety of technologies are widely available to use for the case where these materials are in high concentrations (i.e. pyrometallurgy, hydrometallurgy, precipitation, cementation, Ion exchange, among others). However, these may not be economical or profitable for the case of low-yield sources. A typical example is vanadium, a metal classified with high potential criticality to the UK according to the BGS reports [3]. Recycling of vanadium from different sources is not an easy task. Vanadium has a complex chemistry and hydrometallurgy cannot cope with levels of vanadium that are not high enough to make the process profitable. In this sense, low grade resources (< 0.4%) are often discarded as they cannot be efficiently extracted. However, novel alternative technologies to exploit these sources (i.e. selective polymeric extraction, ionic liquids, deep eutectic solvents) are available but need further investment to develop them to the full potential. The use of these technologies and their potential use with different waste sources needs to be explored and documented so they can become quickly available when needed. We are lucky that in the UK the technological and academic sectors possess the know-how for many of these novel technologies, as shown in the latest RSC Emerging Technologies Competition in 2022. Moreover, this need to increase recycling and technological development was already identified in 2019 in a Postnote communication from the Parliamentary Office of Science & Technology of the Houses of Parliament [4], where increasing recycling and the need to step up research in new technologies for low yield sources were highlighted. This document not only explicitly mentions the economic savings from using a circular economy approach, but also refers to the low level of recycling existing in the UK and EU and the lack of new technologies for the effective recycling of certain elements in the critical list ( i.e. gallium and germanium).

**3. Lessons learned from steps taken by other countries to reduce vulnerabilities of mineral supply chains.**

A viable alternative suggested by many, including some Government sources, is to rely on supply of these materials from allied or friendly countries so the supply will be resilient to geopolitical instability. While this is highly desirable and a first step towards stability, there is an element of uncertainty involving transport that may affect the supply giving our nature as an island nation and this needs to be factored in when considering this option. This option,

also considered by our closest allies, is not the only one in their repertoire of actions. The EU is adopting a policy of creating supranational reserves of these strategic materials, pooling resources towards an Important Project of Common Interest (IPCFI). Identification of natural and waste sources of these elements in their territories, as commented in section 2, in order to secure a stable supply is one step that other allied countries in our sphere have already implemented [5]. Also, a step in the right direction would also involve negotiations on accessing and securing trading of these resources with continental Europe. We need to establish security agreements with the EU to maintain a minimum supply in case of need, so our common defence goals could be protected against hostile states.

Another lesson to learn from other countries' strategies also involves technological substitution of those materials that may create a vulnerability in our supply chain. The EU in its policy document [5] establishes a series of actions (concretely, action 3) towards this point, using R&I through their research programmes (Horizon Europe, European Regional Development funds and national R&I programmes. While this is a valid point, it is a long-term strategy and we need to consider that replacing some of the existing materials is not a viable option in the short or medium-term, specially from an industrial point of view.

Emphasis in the recycling is an important area in our EU neighbours' strategy. Although they clearly point out that recycling will not be enough on its own, it will help reducing the need of mining and imports of several critical elements, reducing environmental impacts and securing industrial availability. They have created a wider strategy to stockpile and preserve key critical materials implemented at supranational level, including stricter controls in exports of waste containing substantial concentrations of these materials. Also, common to the UK strategy, they have presented in their critical material resilience document (action 4) the identification and analysis of critical elements in waste already mentioned in section 2 of this written evidence.

**4. Risks to international security of having mid-stream processing concentrated in a handful of countries.**

The EU document 'Critical materials for Strategic Technologies and Sectors in the EU: A Foresight Study' [6] presents an interesting starting point for discussion. This document identifies a series of critical technological developments and their dependence on certain materials and includes countries in each of the different parts of the supply chain (raw materials, processed materials, components, assemblies). It is interesting to observe that some technologies are in relatively safe hands with most of the processes covered in the EU

or US (Batteries, 3D printing) while other sectors (power generators, robotics, drone technology) present a mixed situation where some processes are in allied countries and others in geopolitically unsecured ones. The worst-case scenario where most processes are in countries where geopolitical issues can generate uncertainty in supply involve traction motors and photovoltaic technologies. This picture clearly shows some potential areas likely to be affected by any political disagreements with other nations or in the worst-case scenario economic war or military conflict. For those cases where only raw materials supply is affected, some of the points raised in sections 2 and 3 may offer potential solutions to ameliorate this problem. For the rest of the unfavourable scenarios described above, a more complex solution is difficult as the UK cannot implement every single step in the supply chain on national soil. A coordinated response with allied countries, including political agreements and national security arrangements with industrial corporations will need to be implemented to secure the development of infrastructure that is able to cover the whole supply chain.

**5. UK guard against hostile states leveraging access to critical minerals**

At present, although the political scenario is volatile, WTO rules are respected and trading and delivery of goods are still in some ways secured. In this present scenario and to safeguard commercial transactions, the UK would need to influence an international political move to establish stricter measures to protect commercial agreements and strengthen sanctions against breaches of previously agreed contractual obligations. This would deter, to a certain extent, unilateral actions taken by hostile actors against the UK. Economic sanctions, agreed with allies and other friendly countries, would also encourage respect for the status quo in trading these critical materials.

In the case scenario of a more hostile environment, the UK would need to be prepared through a combination of measures described in sections 2, 3 and 4, to establish its own supply until the situation can be restored or the technological need disappears.

Dr Jose Gonzalez-Rodriguez

Founder of ESE and Associate Professor. University of Lincoln

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**References**

[1] Resilience for the future: The United Kingdom's critical minerals strategy. HM Government (2022)

[2] Securing sustainable supply of critical raw materials for the UK: good practice and recommendations for improvement. UK Critical Minerals Intelligence Centre. British Geological Survey 2022.

[3] UK criticality assessment of technology critical minerals and metals. British Geological survey (2021)

[4] Access to Critical Materials. Postnote number 609 September 2019. Houses of Parliament

[5] Critical Raw Materials Resilience: charting a path towards greater security and sustainability. Communication from the Commission to the European Parliament, The Council, The European Economic and Social Committee and the Committee of the Regions. European Commission (2020).

[6] Critical materials for Strategic Technologies and Sectors in the EU: A Foresight Study. European Commission, 2020.

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