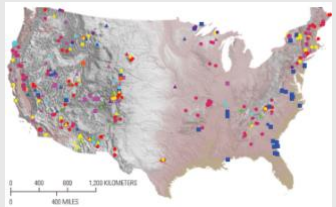
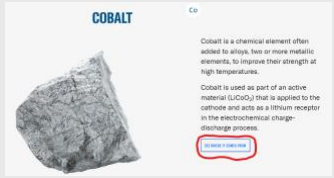
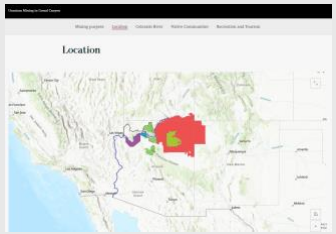
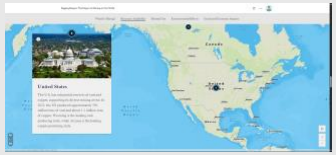
Extraction to E waste: An exploration into the life cycle of a mineral and a more sustainable future.

Students will explore the lifecycle of a mineral from the mine to its disposal in the Xplorlabs extraction to e-waste pathway. Throughout this learning experience students use data, carry out investigations and create maps to develop a deeper understanding of the issues involved in mining, producing, transporting, using and disposing of our most significant minerals.

Instructional phases	**Engage**	**Explore**	**Explain**	**Elaborate**	**Evaluate**
Visual storyline	 	   	   	 	    
Standards	**HS.E1U3.14** Engage in argument from evidence about the availability of natural resources, occurrence of natural hazards, changes in climate, and human activity and how they influence each other **HS.E1U1.12** Develop and use models of the Earth that explains the role of energy and matter in Earth's constantly changing internal and external systems (geosphere, hydrosphere, atmosphere, biosphere). **HS+E.E1U3.11** Develop and use a quantitative model to illustrate the relationship among Earth systems and the degree to which those relationships are being modified due to human activity.				

Timing	1-2 days	1 day	1 day ***Air quality monitoring can be ongoing***	1 day	2-3 days ***Extended time for competition***
Overview	**Engage (Part 1)** Students analyze infographics on minerals used in cell phones and throughout a cityscape to identify patterns in mineral type and use. **Engage (Part 2)** Students play the "Tree Game" to simulate the overuse of resources in an ecosystem and then design a new set of rules for sustainably managing the forest. *The focus of this section is on engaging students by allowing them to explore the many critical and rare minerals that make up the many things we use daily. Students are then introduced to the idea of Tragedy of the Commons and the negative effects of overconsumption.*	**Explore (Part 1)** Students complete the ArcGIS geoinquiry to identify patterns and trends between wealthy countries and countries that consume the most energy. **Explore (Part 2)** Using the Xplorlabs extraction to e-waste pathway, students will use maps to identify patterns and trends in the global extraction, production, transportation, use, and disposal of Li-ion batteries. *The focus of this section is visualizing the differences in where minerals are being extracted, who is using them, and who is suffering from the greatest environmental impact. The goal is for students to identify interests that they can focus on further later in the evaluate section.*	Students will carry out an investigation to explain how pollution spreads throughout an ecosystem. There are several options for completing this section. (1) Modeling watershed pollution: Students build a model to observe how pollution can spread throughout a watershed. (2) Air Quality Monitoring with pocketlab sensors. *The focus in this section is completing an investigation on pollution tied to a link on the battery supply chain. The modeling watershed pollution section focuses on water pollution impacts from mining, whereas the air quality monitoring can focus on greenhouse gasses from transport and production.*	Students will use a case study of the Gold King Mine Spill on the Animas River in Colorado to explain how pollution from a mine can spread. **Part 1** Students read an article on the Gold King Mine Spill and answer discussion questions related to the background and impacts. **Part 2** Students do a group jigsaw, taking a systems thinking approach to understanding the mine spill. Students focus on several topics related to the cause and effect of the mine spill before returning to a home group to put together an understanding of the whole story.	Students will create a story map as a final project using ArcGIS. Students will complete the project based on an area of interest from the previous lessons. The story maps are interactive narratives that incorporate maps, media and text to tell a story. *Note: Students need to have an ArcGIS account to create the maps. Teachers can request the accounts for free.* **Extension** Enter Arizona-based story map projects into the AGIC Student Story Map competition. Some students created new projects specifically to enter into the competition.
Supporting Documents	Xplorlabs Lithium Ion Cityscape Minerals in cell phones The Tree Game and Tragedy of the Commons Resources	Critical Minerals Map Xplorlabs Extraction to E Waste	Modeling Watershed Pollution AZDEQ pocketlab air quality monitoring Data collection form	Gold King Mine Spill Questions and jigsaw focus groups Gold King Mine Spill Text	Story map planning document and Story Map Rubric AGIC Story Map Competition Account Requests for ArcGIS Student Accounts