ROVING WITH ROSALIND: ENGAGING UNDERSERVED SCHOOL PUPILS THROUGH EXOMARS.

S. Motaghian[1,2], A. C. O'Brien[3], Z. Gladman[3] and K. Worrall[3]. [1]Department of Earth Sciences, Natural History Museum, London, UK (s.motaghian@nhm.ac.uk) [2] Imperial College London, UK [3]University of Glasgow, Scotland, UK.

Introduction: Roving With Rosalind (RWR) is a suite of educational resources aimed at school pupils aged 7-14 across the UK to improve engagement with the ESA/ROSCOSMOS ExoMars mission ahead of its arrival at Mars. With the UK Space Agency's (UKSA) aim for the UK to make up 10% of the global sector by 2030 [1], a significant investment is required to enhance engagement and uptake of Science, Technology, Engineering and Maths (STEM) subjects to meet the growing sector's demands. Furthermore, the space sector in the UK is less diverse than many other industries [2].

Our aim is to help inspire and educate a diverse group of young people on the space industry and provide them with tools for the future. This project will create and send portable kits with a myriad of STEM resources mapped to the UK curricula removing financial and geographical barriers to school participation. The kits will consist of ExoMars-based problems and activities; career resources and interviews with a variety of space industry personnel; practical programming; and robotics activities to fully encapsulate the breadth of career opportunities in the UK space sector, arming students with the basic skills and knowledge involved in a mission using ExoMars2020 mission as context.

ESA's ExoMars rover mission is scheduled to launch in summer 2020. Its payload, the Rosalind Franklin rover, is an instrumentation suite primed to search for signs of past or present life on the red planet [3]. The ExoMars mission is a pan-European mission, first envisaged in 2001, and was assembled by Airbus in Stevenage, UK. UKSA have funded Roving With Rosalind as part of their Aurora Science Education and Outreach scheme to harness the impact of the ExoMars mission to engage and educate students in the UK. The main objective of RWR is to inspire pupils with limited exposure to space and STEM outreach, such as those from lower socio-economic backgrounds and rural communities, less able to engage with universities, museums and science centres. This will be achieved through free postable ExoMars-based classroom activities created for teachers under the following themes and skills:

1. Understand data, time, operational and power constraints during mission operation
2. Process of rover design and evaluating engineering trade-off decisions
3. Principles of planetary science and remote sensing
4. Data interpretation with limited rover communications
5. Improve coding skills through programmable rovers
6. Increasing exposure of pupils to mission specialists and insight into space careers

We will also train teachers, university students and school technicians to deliver these activities effectively by providing free Continuing Professional Development (CPD) workshops across the UK. CPD sessions will also allow us to gain feedback on how to improve the resources.

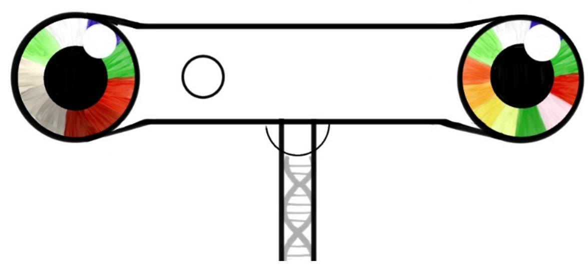

Figure 1. *RwR Logo, incorporating the 'eyes' of the Rosalind Franklin Rover (PanCam) and DNA strand in the rover mast, after Franklin's contribution to the discovery of its structure*

Rationale: Approaches to STEM outreach and engagement in the UK are increasingly based on the concept of 'Science Capital'. Science Capital can be summarised as how much science a person knows, how much they talk about it and to what level they are exposed to/engage in science [4]. The less Science Capital someone has, the less likely they are to pursue science beyond age 16 (science is obligatory up to this age in the UK) [4]. Statistically, people from lower socio-economic groups have lower Science Capital than those of higher socio-economic groups. There is also variation amongst ethnic groups e.g. South Asian boys from a high socio-economic background are the most likely demographic group to have high Science Capital [5].

With RWR we are developing and delivering activities with a Science Capital approach, which promotes a holistic view of science and its value to school pupils. This means, for example, avoiding promoting science only as a means to become a scientist, but as a useful asset for many other careers. To that end, we will be showcasing a diverse range of role models employed in a range of jobs related to space, exemplifying how science can help with many career paths. Ensuring a range of demographic groups are represented also promotes a positive Science Capital approach whereby pupils from under-represented groups can 'see themselves' in space-related roles.

Project Overview: For this project, self-contained kits with all necessary resources to deliver the activities will be loaned to schools for free. Each main activity will have a corresponding introductory video, whereby an expert who works in the area outlines their tasks and explains how it is relevant to real Mars exploration as well as their own career and background. Selected activities are outlined below:

Mars Mission Role Assignment: A careers quiz will be hosted on SpaceCareers.uk for pupils to complete online to find their suggested role in a Mars Mission, showcasing the wide range of people and jobs involved in order to explore the red planet in a format they recognise. Students will subsequently trial each of these career goals and find which they prefer.

Rover and Instrument Design: Pupils will complete a basic design activity, choosing different elements for their rover (e.g. number of wheels, power source etc) under mission constraints. Pupils will then be introduced to multiple mission instruments and how they are used. Lastly, they will go on to build their own simple spectroscopes, using diffraction grating paper, allowing them to create a basic version of key mission instrumentation onboard the Rosalind Franklin rover.

Analogue Exploration: Pupils will experience an analogue mission by working in small groups with one student acting as the rover, whilst the others give them instructions. As the 'rover' visits key sites of interest they will relay puzzles that mission control must solve in order to access the samples. In order to help students understand the data and time constraints of mission operations, they will then communicate with limited information transfer i.e. 5 words or less. Students will swap roles and be able to trial each operational role.

Remote Controlled Exploration: Pupils will use app-controlled rovers to explore a large map of Mars, identifying and navigating to locations of interest. Exploration routes will be planned beforehand, using basic mathematical, scientific and engineering concepts such as speed, power, time and the associated trade-offs to choose how many and which regions of interest (ROIs) to investigate. As rovers reach a ROI, students will solve puzzles and 'data downlink' files will be released, containing problem-solving activities which will give them geological information about the ROI. Problem-solving tasks will be based around rover instrument suites: They will receive PanCam and HRC images of their selected target, examples shown in Figure 2. They will also be provided with spectral data whereby pupils will receive multispectral datasets from the ROI (example left Figure 2) to compare with reference hyperspectral data files of several geological targets (example centre Figure 3), to determine the potential mineralogy present at the ROI. Information sheets will be provided alongside reference spectra, allowing pupils to learn the geological history of the ROI (e.g. presence of hydrated minerals, weathering etc.) to decide whether they are a likely area for past or present life.

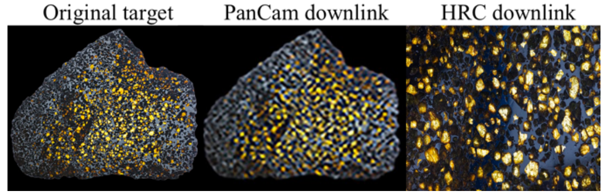

Figure 2. *Example PanCam downlink file. Original Images from the Natural History Museum London, Imilac Meteorite.*

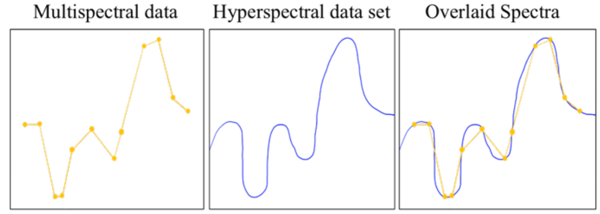

Figure 3. *Example Spectral downlink files. Left: Multispectral PanCam data, Centre: Hyperspectral reference spectra, Right: Overlaid spectral comparison.*

Programming Exploration: Programmable rovers will be provided for pupils to develop basic coding skills by planning and executing a simple route on a large map of the Martian surface. Coding is an obligatory part of the National Curriculum in England and Wales [6] as well as the Scottish Curriculum for Excellence [7], meaning that all school pupils are expected to learn the basics of the topic. As it is a recently added it is beneficial to provide teachers with additional teaching materials in this area. This alleviates pressure for teachers with limited programming backgrounds and improve confidence in material delivery.

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References:

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