AN ESA ROBOTIC PACKAGE TO SEARCH FOR LIFE ON MARS. F. Westall[1], A. Brack, P. Clancy, B. Hofman, G. Horneck, G. Kurat, J. Maxwell, G. G. Ori, C. Pillinger, F. Raulin, N. Thomas, and B. Fitton, [1]Mail Code SN2, NASA Johnson Space Center, Houston TX 77058.

Similarities in the early histories of Mars and Earth suggest that life may have arisen on Mars as it did on Earth [1]. The early life forms on Mars were probably simple organisms, similar to terrestrial prokaryotes [2]. In fact, given the early deterioration of the Martian climate [3,4], it is unlikely that life on Mars could ever have reached more sophisticated evolution. On Earth, eukaryotes appeared only around 2.1 Ga [5], about two billion years after the first signs of life on Earth [6,7]. Based on the present knowledge of Mars, the possibility of extant life at the surface is small. However, given the adaptability of terrestrial prokaryotes under adverse conditions [8,9,10,11], it is not excluded. Any extant life is hypothesised to reside in the permafrost in a dormant state until "reanimated" by impact-caused hydrothermal activity.

Using this rationale, a multidisciplinary group of European scientists (listed above) worked together in 1997-1998 to conceive a hypothetical strategy to search for life on Mars [12]. The strategy consists of (1) identifying a landing site with good exobiological potential, and (2) searching for morphological and biogeochemical signatures of extinct and extant life on the surface, in the regolith subsurface, and within rocks. The platform to be used for this theoretical exercise is an integrated, multifunctional instrument package, distributed between a lander and a rover, which will observe and analyse surface and subsurface samples to obtain the following information:

(a) Environmental data concerning the surface geology and minerology, UV radiation and oxidation processes;
(b) Macroscopic to microscopic morphological evidence of life;
(c) Biogeochemistry indicative of the presence of extinct or extant life;
(d) Niches for extant life.

Our strategy is designed to be a guideline for future missions and is not aimed at any one particular mission. Parts of this strategy will be used in the 2003 Mars Express mission on the planned Beagle II exobiology lander.

The scientific objectives and required instrumentation are listed below. Some of this instrumentation will need to be developed for space flight and planetary exploration, and much of it has already been developed and flown in space, or will fly on imminent missions.

Objective 1: Landing site with exobiological potential

Task	Instrument
Topography	MOC/MOLA images from MGS and other missions
Mineralogy	TES from previous missions
Site survey/ target selection	Panoramic camera

Objective 2. Visible evidence of life

Task	Instrument
Microbial etch marks, buildups (stromatolites, bioherms), crusts	Panoramic camera (for large scale buildups) Low and high resolution optical microscope
Organism morphology	Low and high resolution optical microscope AFM
Biominerals (carbonates, oxalates, phosphates, silica, Fe/Mn oxides, Fe sulphides)	Low and high resolution optical microscope AFM

Objective 3. Biochemical signatures of life

Task	Instrument
Biologically important elements (C, H, N, O, S, P)	APX spectrometer
Biologically important isotopes and ratios ($^{12}C/^{13}C$, $^{15}N/^{14}N$, $^{34}S/^{32}S$)	Pyrolitic GC-MS LA-ICP-MS
Biologically important molecules (H_2O, CO_2, NO_2, NO_3, N_xO_y, SO_2/SO_3, phosphates)	Pyrolitic GC-MS (Thermal) IR spectroscopy Raman spectroscopy Electron probe
Homochirality	Pyrolitic GC-MS

Objective 4. Mineralogy/geochemistry

Task	Instrumentation
Rock/regolith/dust composition Biominerals	Optical microscope APX Mössbauer spectroscopy Raman spectroscopy IR spectroscopy XRD Electron probe UV spectroscopy

Objective 5. Environmental detection

Task	Instrumentation
UV	UVdetector
Oxidant	Oxidant detector

Objective 6. Sample acquisition, distribution and preparation

Task	Instrumentation
Soil samples	Scoop
Dust/weathering rind remover	Grinding device
Consolidated regolith penetration	Core drill or mole
Rock penetration	Drill, chipper
Magnetic grain separation	Magnetic separation device
Sample transfer	Manipulator
Surface smoothening	saw
Sample crushing for analysis	Grinder

The instrumentation will be divided between a rover and a lander with the lander being the center for subsurface consolidated regolith sampling and for *in situ* sample preparation and analysis. The rover then provides a selection of rock samples from nearby locations either as small core samples or as small rock (cms) for sawing in the lander. The following table shows a possible lander/rover instrumentation configuration.

Rover		Lander	
Instrument	**Weight (kg)**	**Instrument**	**Weight (kg)**
Robotic positioning arm	2.0	Subsurface drill	6.5
Rock surface grinder	0.4	Sample handling/distrib-ution	4.0
Low resolution microscope	0.2	Sample sectioning	0.3
APX	0.5	Sample grinding	0.4
Small rock coring drill	3.5	Low resolution microscope	0.2
Core sample containers	0.5	Optical microscope	0.3
		AFM	1.5
		Microscope transfer stage	1.0
		APX spectrometer	0.5
		Mössbauer spectrometer	0.5
		Raman spectrometer	1.5
		IR spectrometer	1.0
		Pyrolitic GC-MS	5.5
		Oxidant detector	0.4
		Laser ablation ICP-MS	2.5
TOTAL	**7.1**		**26.1**

Acknowledgements: The team is grateful to the Manned spaceflight and Microgravity Directorate division of the European Space Agency for support for this project.

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