Geologic Material Processing

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Session outline

- Introduction to issues and actions associated with obtaining feedstock material
- Identify equipment commonly associated with sample processing
- Preparation/testing of simulant samples
- Introduction to new technology as it applies to simulant development
Identification of starting material

• Need for specific components, proper mineralogy
  Major, Minor, Trace
• Identification of source material
  Stillwater Mine, Nye, MT
• Long term viability of source material, variation
• Access
  Collection, Transport, Permitted ground
Material collection, transport
Sample collection

- Physical sample size, collection equip?
- Collection conditions
  - Ability to centralize material collection
  - Roads, Tram
  - Weather conditions (moisture)
- Infrastructure
  - Freight access, Cost factor
  - Container costs
Waste dump characteristics

Advantages
- Sample size manageable
- Good logistical arrangement
- Long term supply

Disadvantage
- Poor sample identification, expertise needed
- Variable composition
Service Road characteristics

Advantages
- Higher quality materials, good collection zones
- Manageable sample collection size
- Acceptable logistical situation (collection time)

Disadvantages
- Limited supply of material (10’s of tons)
- Not amenable to large scale collection operation
- Seasonal access issues

Collection effort provided 10 tons of material, two days
Sample processing equipment

- Crushers (all sizes)
  Start 10’s cm crush to 1-2 cm
- Grinders/Mills
  Start 1-2 cm down to millimeters to microns
- Issues of concern
  Contamination of sample with grinding media
  Time for sample processing
  Particle size distribution
Corundum grinding media
Vibratory Rod Mill
Steel grinding rods
Jet Mill

Sample exit

Sample input

Air injection
Particle size reduction is accomplished using a series of standing shock wave in the reaction chamber to cleave particles at points of structural weakness.
Horizontal Plate grinder

Zirconium grinding plates
Sample splitting

- Procedures
  - Cone and quartering
  - Riffle splitter, Jones splitter
  - Spinning Riffler (SR)
- SR optimal design for sample consistency
- Repeated contribution of starting material to each container
Lunar Highlands Type simulant
Medium Grain size
NU-LHT-2M
Property measurements

• Chemical analysis
  Total - WDXRF, ICP-MS
  Extractive - Gastric, Lung fluid leach
• Size, shape, Mineralogical analysis (QCMs)
  SEM, EPMA, Sieving, Laser Def., Others
• Additional physical properties
• Consensus values by round robin testing
Advances in simulant development

- Collaborative effort with Zybeck Advance Prod.

HQ glass
Agglutinate glass (video)
Synthetic Breccia, NU-LHT-2C
Synthetic Minerals, Anorthite (An95) (video)
Plasma Technology

- Remotely-coupled transferred arcs
  - Non-conductive material rapidly heated / cooled
  - Extreme thermal gradient
  - Power density - 140 MW/m³
- Glass exit temperatures 1,300–1,925 °C. Up to 150 kg/hr
- Plasma temperatures 13,000 K to 21,000 K
  - Typically run at 600 to 1,200 amps
Breccia in Lunar regolith

- Breccia is a rock composed of angular fragments (clasts) cemented together by matrix material.
- At Apollo 16 site 95% of regolith impact breccia.
- Breccia more friable impact on mechanical prop.

- Synthetic breccia using Stillwater sand, crushed Norite and Anorthosite.
Breccia video
Future USGS directions

• Development of LHT-3M ~ 4 tons  June 2009
• Sources rock for mineral separates
  Domestic
  International
• Develop procedures for mass production of synthetic minerals
• Develop mineral separation procedures