Two new basaltic objects in the Outer Main Belt

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Introduction:
The Vesta Conundrum and the basaltic material

- HED meteorites
- The identification of a Vesta dynamical family (Williams, 1989; Zappalá et al., 1990).
- The confirmation that small basaltic asteroids in the region near (4) Vesta (Binzel and Xu, 1993; Burbine et al., 2001).
- The identification of a large impact basin on (4) Vesta (Thomas et al., 1997).
- The discovery of several basaltic NEAs (McFadden et al., 1985; Cruikshank et al., 1991; Binzel et al., 2004; Duffard et al., 2006).
Vesta

- The discovery of a small basaltic asteroid, (1459) Magnya (Lazzaro et al., 2000; Michtchenko et al., 2002).

- Evidence that most of the HED derived from a common well-mixed pool. (exception for Northwest Africa 011 (Yamaguchi et al., 2002) as well as Ibitira (Wiechert et al., 2004)

- Result of a differentiation process (heating and melting of the interior)
Did all the V-type asteroids came from Vesta?

NEAs
HEDs

Iron meteorites → 60 differentiated parent bodies
V-type asteroids and NEAs - HED meteorites

Previous analysis:
Other V-type ??

• In the inner asteroid belt (Florczak et al. 2002)

• Spectroscopic Surveys:
  – SMASS (Xu et al. 1995; Bus & Binzel, 2002; Burbine & Binzel, 2002)
  – S3OS2 (Lazzaro et al. 2004)

  – Total of 2400 objects
Sloan Digital Sky Survey

– Moving Objects Catalog (MOC):
  • 204.605 observations
  • 67.637 linked to known asteroids (43.424 objects)

<table>
<thead>
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<th>Filter</th>
<th>$\lambda$ central</th>
<th>Limit mag.</th>
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<td>$g$</td>
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<td>$r$</td>
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<td>$i$</td>
<td>7481</td>
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<td>$z$</td>
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Principal component analysis

• 34.277 “spectra”

Some examples

3869 Norton (S)

4055 Magellan

5481 Kiuchi (S3OS2)

Normalized at 6165 Å
Type V distribution

8 candidates with $a > 2.5$ AU

(21238) 1995 WV7 also identified by Binzel et al (2007) LPSC XXXVIII
Observations with CAFOS@Calar Alto 2.2m Telescope, Spain

![Graph showing reflectance against wavelength for (7472) Kumakiri and (10587) 1991 RY16]
<table>
<thead>
<tr>
<th>Asteroid</th>
<th>$a_p$ [AU]</th>
<th>$e_p$</th>
<th>$\sin I_p$</th>
<th>$g_{s57}$</th>
<th>$g_{s66}$</th>
<th>$g_{s77}$</th>
<th>$D$ [km]</th>
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<tbody>
<tr>
<td>(1459) Magnya</td>
<td>3.14986</td>
<td>0.2183</td>
<td>0.2651</td>
<td>-5.664</td>
<td>-6.299</td>
<td>-4.493</td>
<td>17.0 ± 1.0</td>
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<tr>
<td>(7472) Kumakiri</td>
<td>3.01033</td>
<td>0.1372</td>
<td>0.1562</td>
<td>-3.588</td>
<td>-4.195</td>
<td>-2.388</td>
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<td>(10537) 1991 RY16</td>
<td>2.84958</td>
<td>0.1023</td>
<td>0.1101</td>
<td>-1.570</td>
<td>-2.207</td>
<td>-0.400</td>
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</table>
A Survey of Basaltic Asteroids in the Main Belt.

Figure 3 ESI spectrum of a potential V-type asteroid. This spectrum shows the blue-edge of the 1 \( \mu m \) basaltic absorption feature and an unusual 0.6 \( \mu m \) absorption feature.
0.6 – 0.7 μm band

- Hydrated minerals? Shock induced oxidation of Fe$^{2+}$ by other asteroids or comets? (Shestopalov et al. 2007)

Olivine band near 0.6 μm (Fe$^{2+}$ in olivine)


0.9 μm band position moved.
V-type ??

- All of them are basaltic
- Mixtures of pyroxene and olivine (grain size ?, space weathering?)
- In all cases the objects are really interesting

Future Work

- Dynamics:
  - not family members,
  - isolated
- NIR observations (Gemini + IRTF)
- Observations to search more objects

Two new basaltic asteroids in the Outer Main Belt.
Duffard & Roig. ArXiv:0704.0230v1