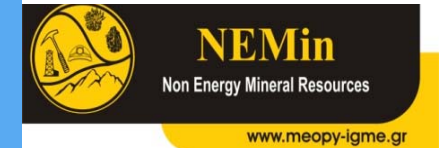




**INSTITUTE OF GEOLOGY AND  
MINERAL EXPLORATION  
(I.G.M.E.)**



**PERSPECTIVES FOR THE PRODUCTION OF INDUSTRIAL  
MINERALS FROM THE EXPLOITATION OF THE WASTE  
STEMMING DURING THE EXTRACTION OF GREEK WHITE  
CALCITIC MARBLES (EASTERN MACEDONIA)**

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# Introduction - 1

- Mining waste → 30% of all the waste stream
- Vigorous action by the new EU member States:
  - To transpose EU legislation into national legislation
  - To conduct special plans for the management of mining waste
  - To Compile cadastres

# Introduction - 2

## Greece

- Production of marbles → Waste rocks equal to 95% of extracted rock
- High whiteness values (>90%) and high calcite content ( $\text{CaCO}_3 > 98\%$ )
- IGME investigating the possibility for feasible co-management of the wastes
- Ideal candidates as raw materials for the production of added-value products (for the production of fillers) in the market of industrial minerals

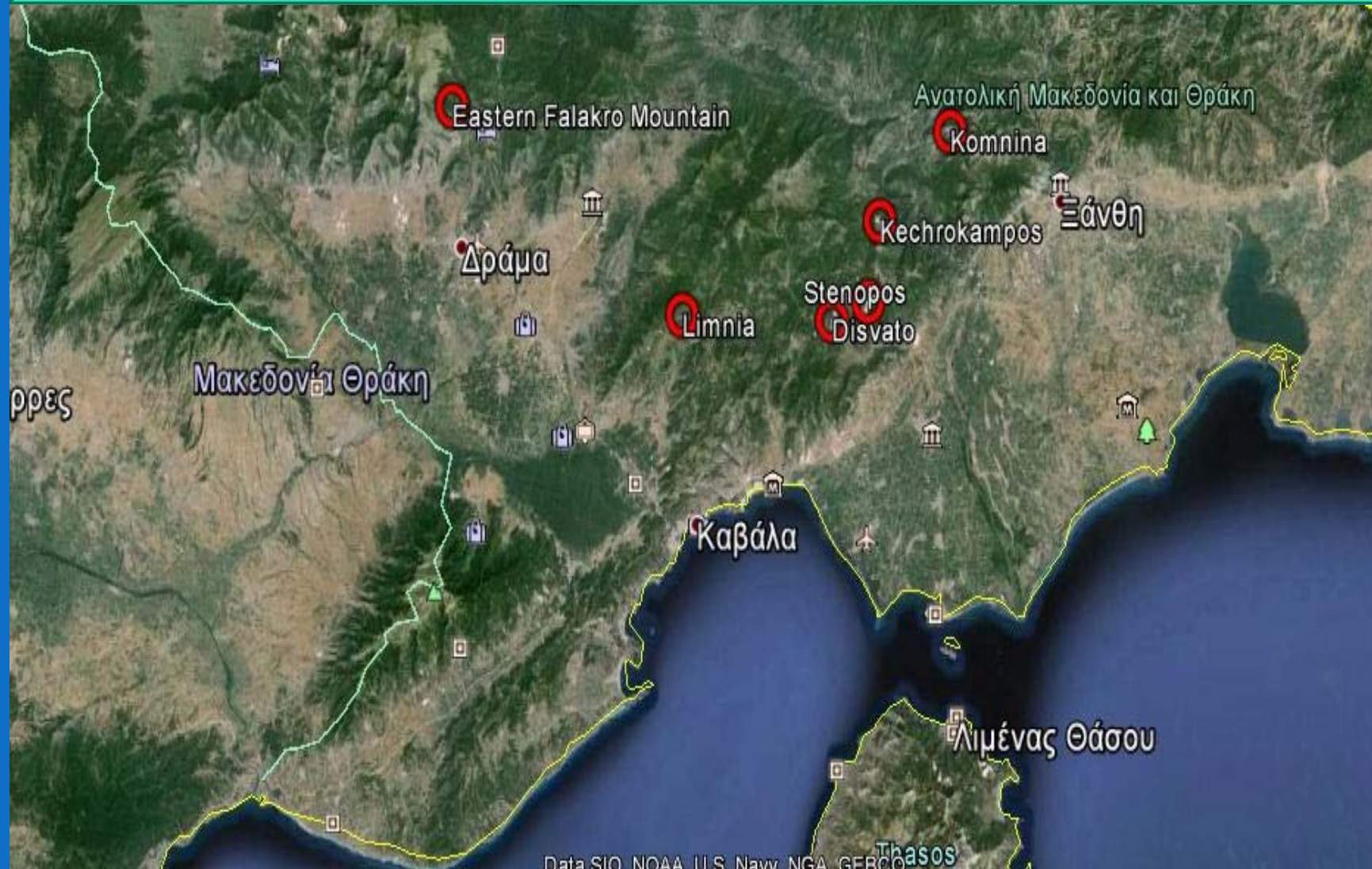
# Material and Methods - 1

- Preparation of a feasibility study for the Eastern Macedonia marble rejects (project within NSRF 2007-2013)
- 5.550.000m<sup>3</sup> or 15.000.000 tons of marble waste have been stockpiled.
- 300.000m<sup>3</sup> (700.000 tons) rejects is still being stockpiled annually.
- Six (6) sub – areas were examined: (1. Disvato, 2. Stenopos, 3. Komnina, 4. Limnia, 5. Falakro Mt, 6. Kechrokampos)

## Material and Methods - 2

- Laboratory test work in order to assess:
  - Whiteness of powders (CIEL\*a\*b\* measurements with a spectrophotometer CARY 100.
  - Purity (CaCO<sub>3</sub> % by synthesizing assays and mineralogical composition)
  - Mechanical / physical, as well as thermal / weathering behavior (EN 1097.02:2011 - Los Angeles test, EN 1097.06:2000 - particle density / water absorption, EN 1367.02:1999 (Magnesium sulfate test))

# Area of Interest - 1





## Area of Interest – 2

The geological study is of extreme importance because:

1. Access to stockpiles is difficult and collection of representative samples is not possible;
2. The hand samples can only be typical of the rock formations that occur in the area;
3. Exploitation of rejects depends on: a) the availability of suitable materials, and b) the possibility to get the desirable qualities;

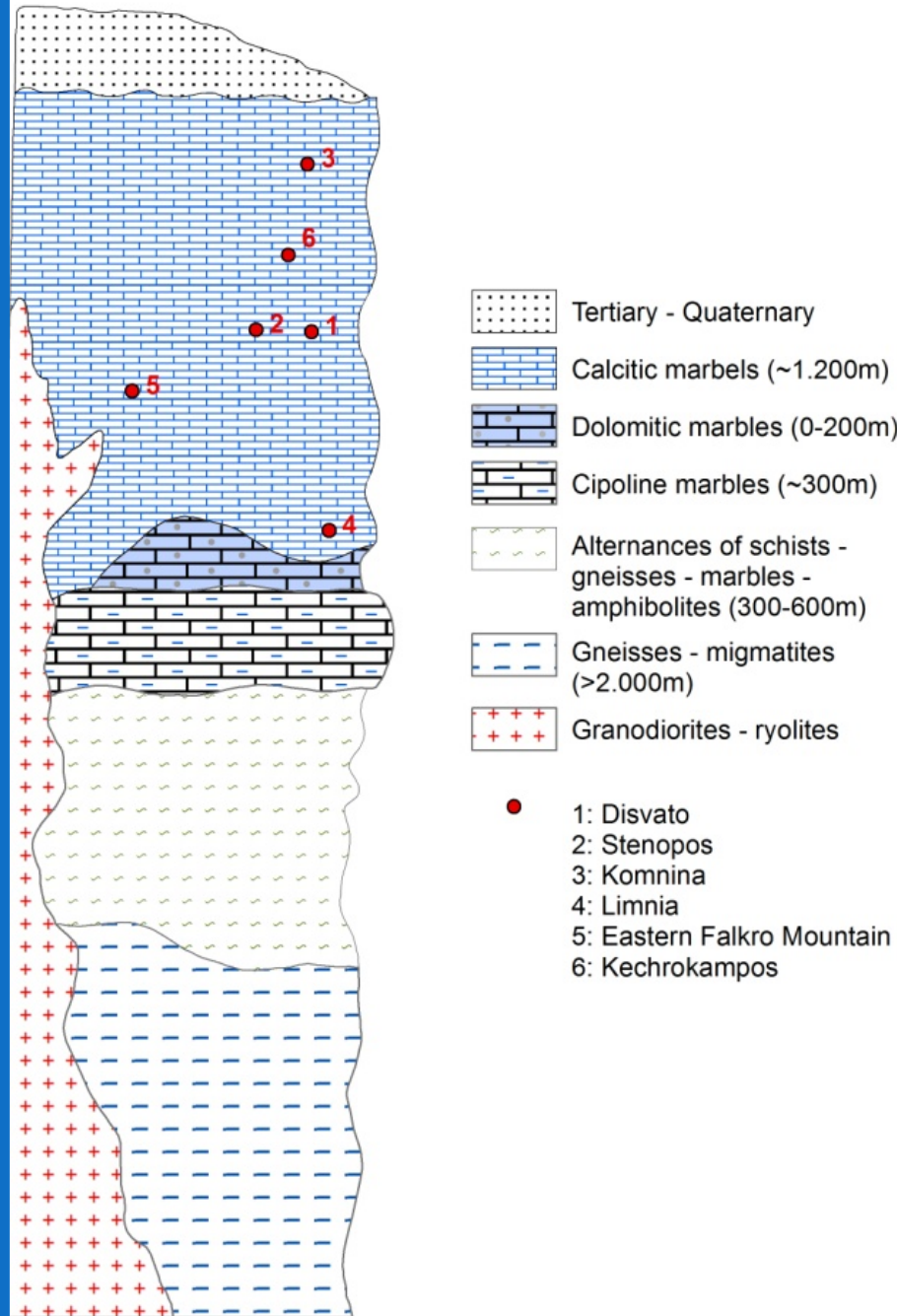


## Area of Interest – 3

The geological study is of extreme importance  
because:

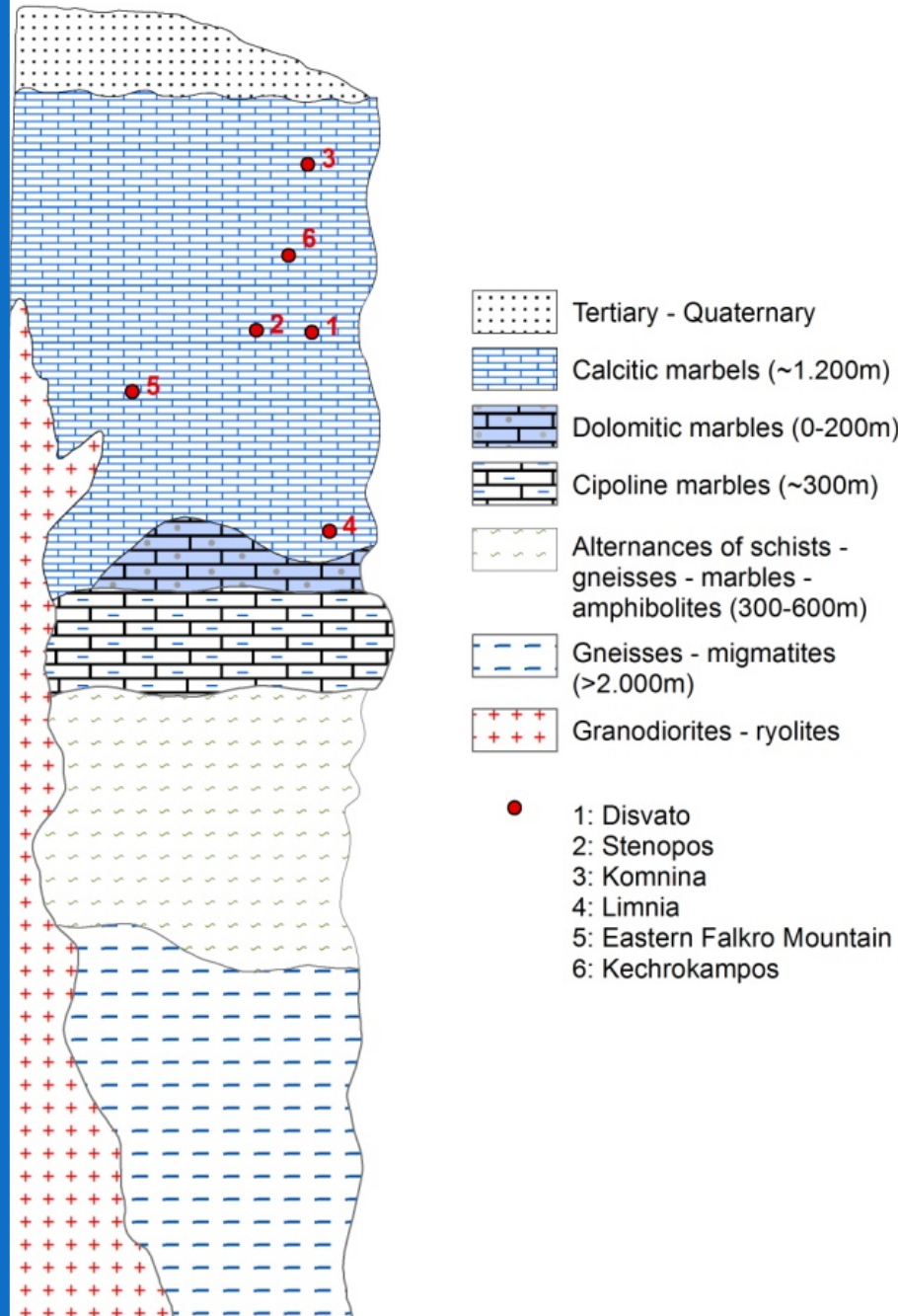
4. Correlation between qualities and quantities must be accomplished with the help of an expert geologist in co-operation of course with a mineralogist;
5. Further proposals for management and exploitation of the marble waste should be based on the results of such investigation.

# Area of Interest – 4



Lithostratigraphic Column of Western Rhodope showing the stratigraphic position of the exploitation areas

# Area of Interest – 5



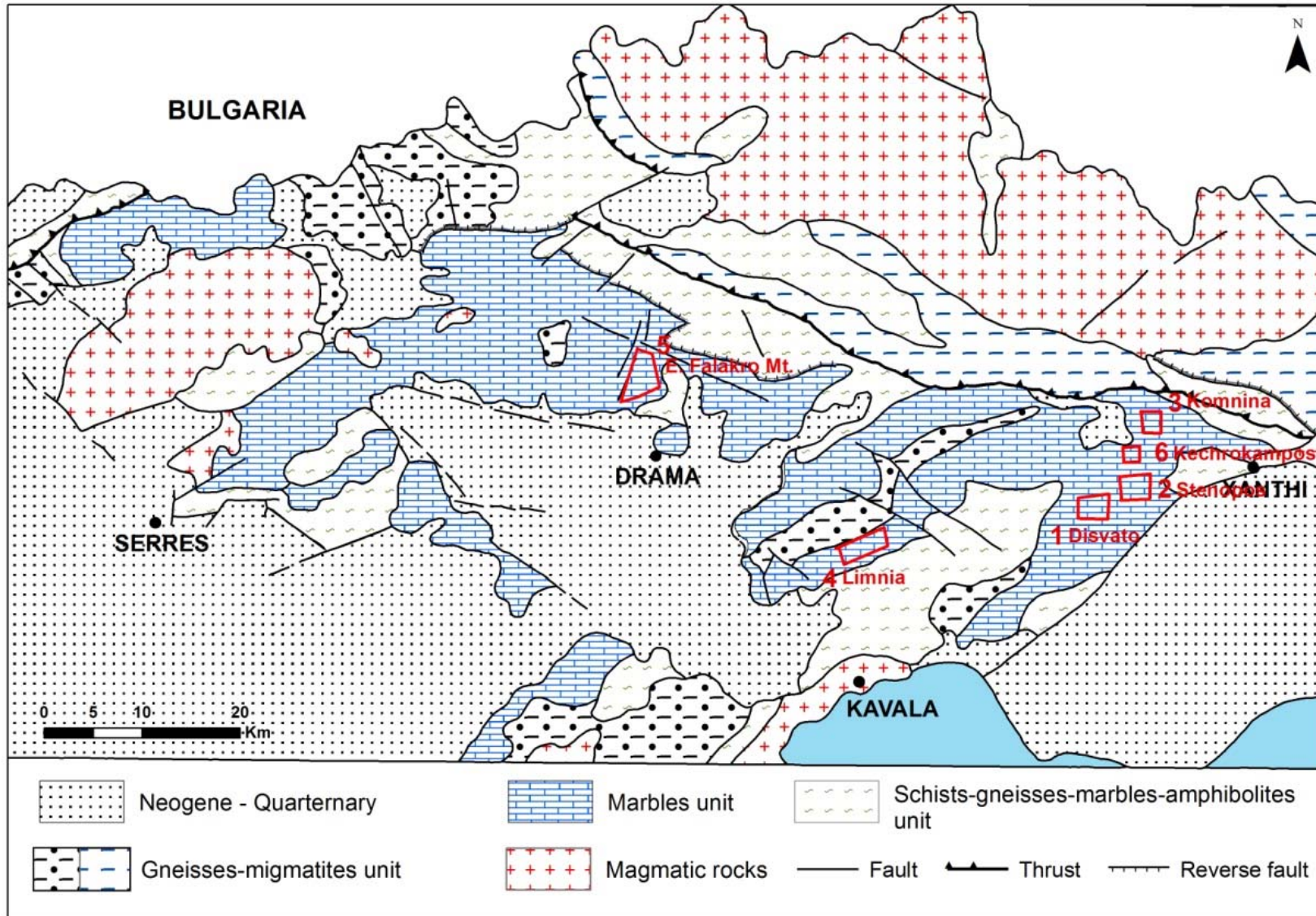
- Three discrete lithological units:
  - a) Marbles unit (Upper unit);
  - b) Alternances unit (Middle unit),
  - and c) Gneisses unit (Lower unit)
- **Marbles unit is of interest for the present:**
  1. The Falakro massif calcitic marbles with a thickness of about 1.200m;
  2. Dolomitic marbles with a thickness from 0 to 200m, and
  3. Banded cipoline marbles with a thickness of about 300m.

## Area of Interest – 6

- The Falakro massif calcitic marbles are holocrystalline and **are almost entirely consistent of pure calcite**. The color varies **from grey to white**.
- At Stenopos, Disvato, Kechrokampos, Komnina, Limnia and Eastern Falakro Mountain, the marbles are exploited as ornamental stones with a rate of 6-7%, due to the existence of intense faulting, deformation and other weathering factors, **resulting in rejection of significant quantities of white to semi-white marble fragments as unusable materials**.



# Area of Interest – 7





# Area of Interest -8 (E. Falakro)



Stockpiled marble wastes



## Area of Interest – 9 (Stenopos)



Stockpiled marble wastes



## Area of Interest – 10 (Limnia)



Stockpiled marble wastes

## Area of Interest – 10

Area	L* (%)	Tristimulus value Y (%)	CaCO <sub>3</sub> , %
1. Disvato	96,9-97,8	92,2-94,5	99
2. Stenopos	97,6-98,2	93,9 – 95,6	98-99
3. Komnina	98,3-98,4	95,7-95,9	99
4. Limnia	96,8-98,1	90,0-95,2	99-100
5. E. Falakro	96,5-98,5	91,2-95,8	98-99
6. Kechrokambos	98,3	95,7	98

Optical properties and CaCO<sub>3</sub> content of the materials in the area under study

# Area of Interest – 11

Area	Calcite, %	Dolomite, %	Others (mainly quartz), %
1. Disvato	96,9-97,3	2,4-2,6	0,3-0,8
2. Stenopos	96,3-96,9	2,7-3	0-0,7
3. Komnina	97-97,3	1,7-2,3	0,6-1
4. Limnia	97-98%	1,5-2,5	0-1
5. E. Falakro	95-97,5	1,3-3,1	1-1,3
6. Kechrokambos	96,5	1,5	0,7-1,8

Mineralogical composition of the materials in the area under study

# Market Aspects – 1

- A market research was conducted very recently (2015) focusing on the potential of producing Ground Calcium Carbonate Fillers (GCC) by using white calcitic marble, updating and verifying the results of a similar study of IGME of 2008.
- The total annual capacity (2015) of the Greek companies producing fillers is 0,8 Mt (almost the same with 2008);
- Despite the economic crisis, the domestic fillers' production has shown slightly upward trends. The sector is highly depending on exports (80%) all over the world.



## Market Aspects – 2



Marble waste prepared to feed a fillers producing mill  
(Stenopos)

The utilization of marble waste has become a common practice for the production of Ground Calcium Carbonate in Greece.

# Discussion - 1

- The sustainable management of **mining waste** has become a **major goal** in Europe with a priority to prevent their production and if produced to pursue their **exploitation as secondary resources**.
- Regarding **Greece**, extraction of **marbles** is an activity which results in **large amounts of waste rocks** equal to 95% of the extracted rock.

## Discussion - 2

- **Eastern Macedonia, is of great interest** due to abundant waste materials coming from the extraction of **white calcitic marbles**.
- Extensive long-time investigation which has been accomplished by IGME, within numerous projects, shows **that it is feasible to use this material in order to feed Ground Calcium Carbonate Fillers Mills**.



## Discussion - 3

- The industry has **made use of the research findings and invested in the field.**
- Currently, the Greek Ground Calcium Carbonate Fillers' sector **is healthy and growing steadily.**
- Incorporation of **best practices** in the management of marble waste by marble quarry operators, taking into account their potential future utilization, needs **further promotion.**

**THE END**

**Thank you for your  
attention**