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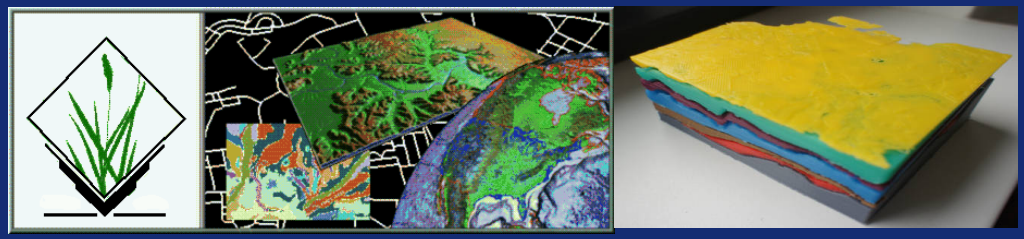
GFZ Helmholtz Centre Potsdam

Scientific 3D Printing with GRASS GIS

A Work in Progress Report



Dr. Peter Löwe

FOSSGIS 2014

2014-03-20

In a nutshell

- Interfacing GRASS GIS with 3D print workflows can be done with the current GRASS modules.
- Prediction: Easy to use GRASS extensions for 3D printing will come soon.
- Scientific 3D prints extend „flat“ 2D science communication
- Decelerated haptic data access (no-display-needed)

- **But there‘s more to it…**

Communicating scientific findings

The challenge:

- Picturing scientific data in one's mind
- Communicating this vision to someone else

The need:

A tangible representation of scientific results.

1492

Today

Future

„The future is here“ (again)

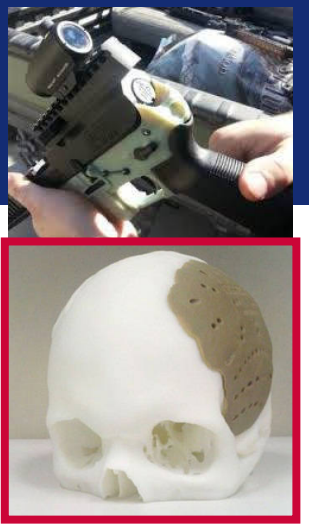
The potential of „3D printing“ as featured in the news:

„The future is here“ (again)

The potential of „3D printing“ as featured in the news:

- **Guns !**

„The future is here“ (again)



The potential of „3D printing“ as featured in the news:

- **Guns !**
- **Human body parts !**

„The future is here“ (again)

The potential of „3D printing“ as featured in the news:

- **Guns !**
- **Human body parts !**
- **Clothes !**

„The future is here“ (again)

The potential of „3D printing“ as featured in the news:

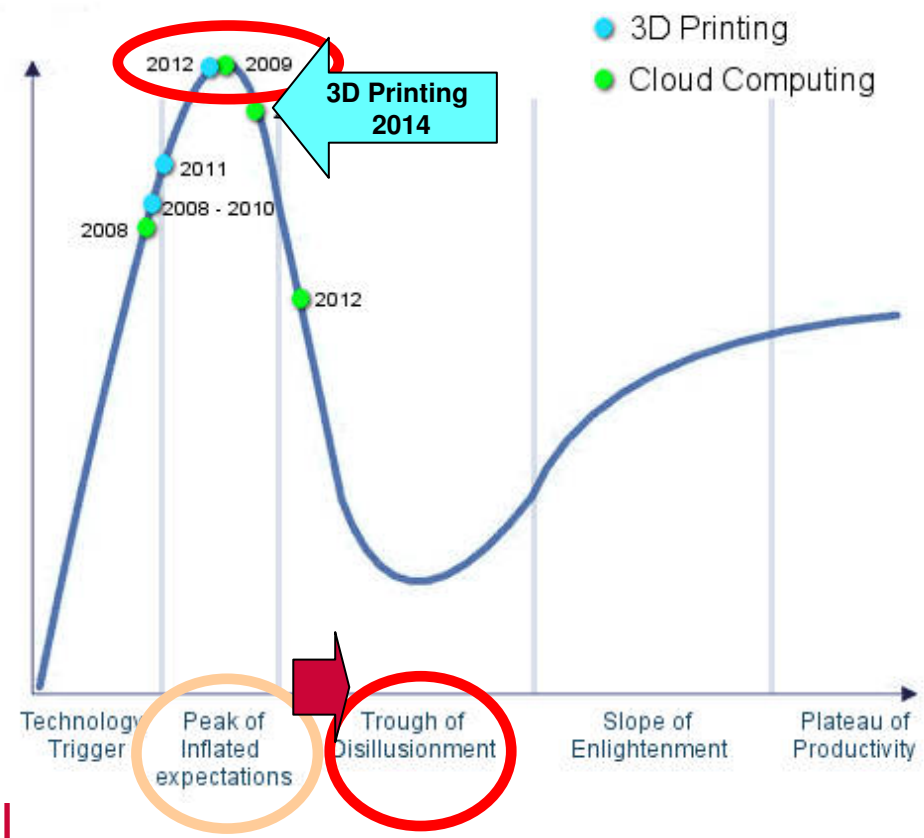
- **Guns !**
- **Human body parts !**
- **Clothes !**
- **Candy !**

„The future is here“ (again)

The potential of „3D printing“ as featured in the news:

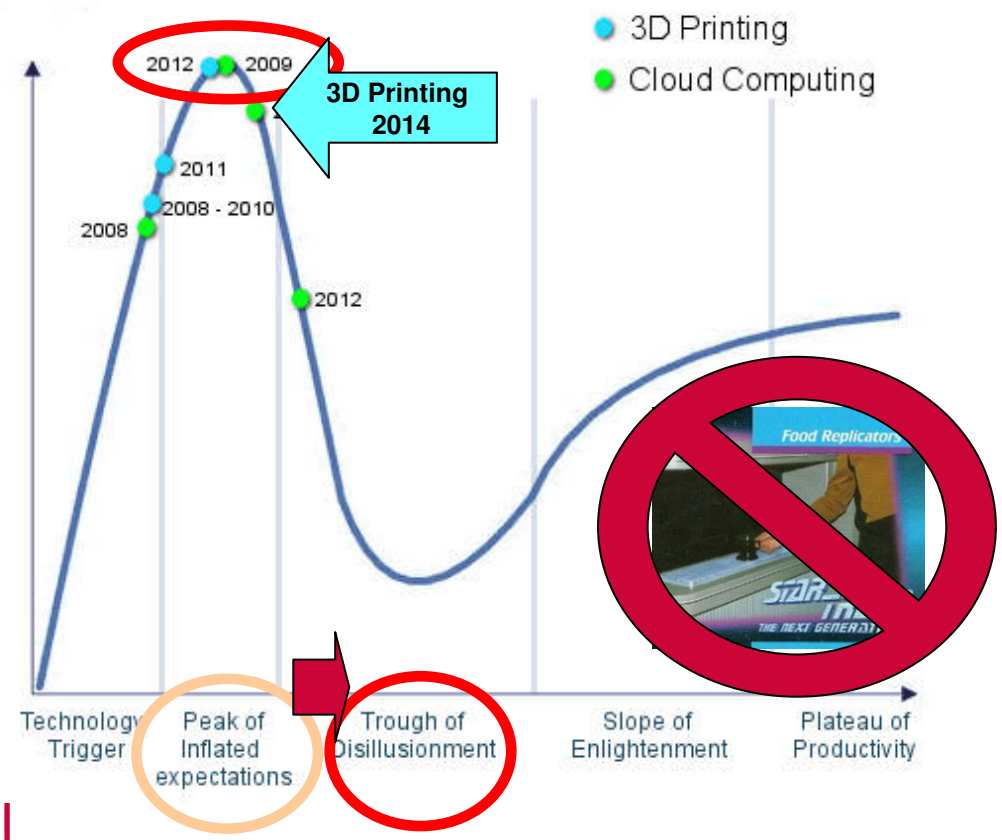
- **Guns !**
- **Human body parts !**
- **Clothes !**
- **Candy !**
- **Space Exploration !**

3D Printing, the Gartner hype cycle, and science



http://surveys.peerproduction.net/wp-content/uploads/2012/11/GoogleTrendsGartnerHypeCycle.png

3D Printing, the Gartner hype cycle, and science



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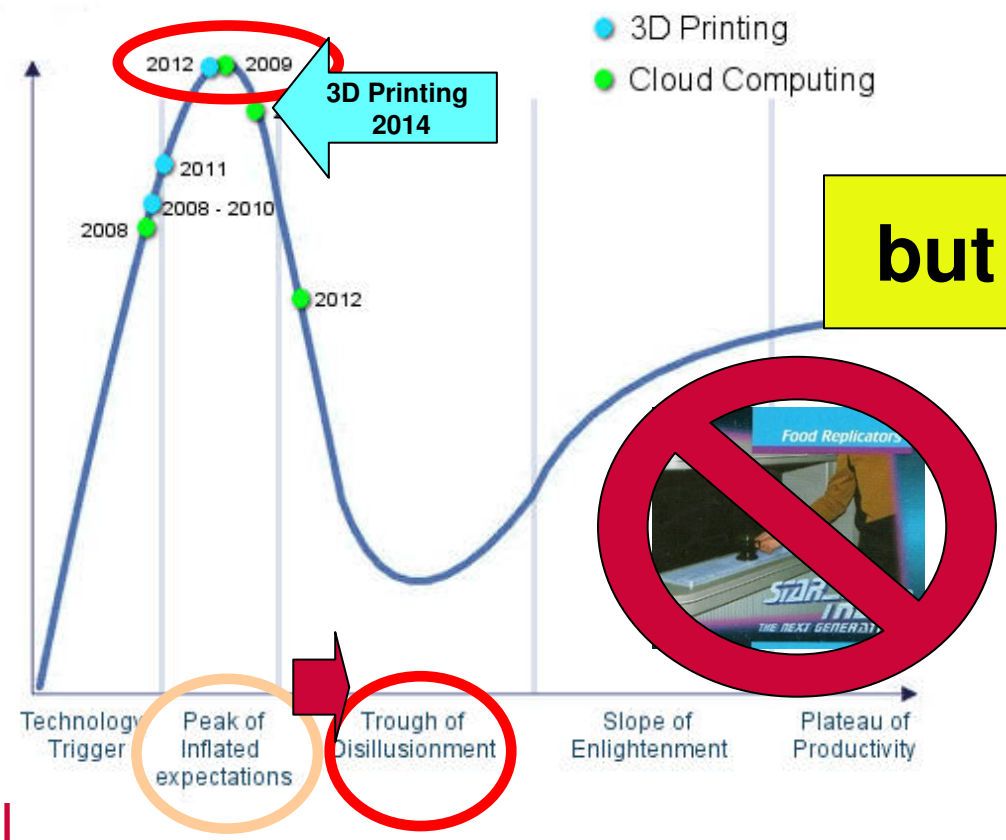
3D Printing, the Gartner hype cycle, and science

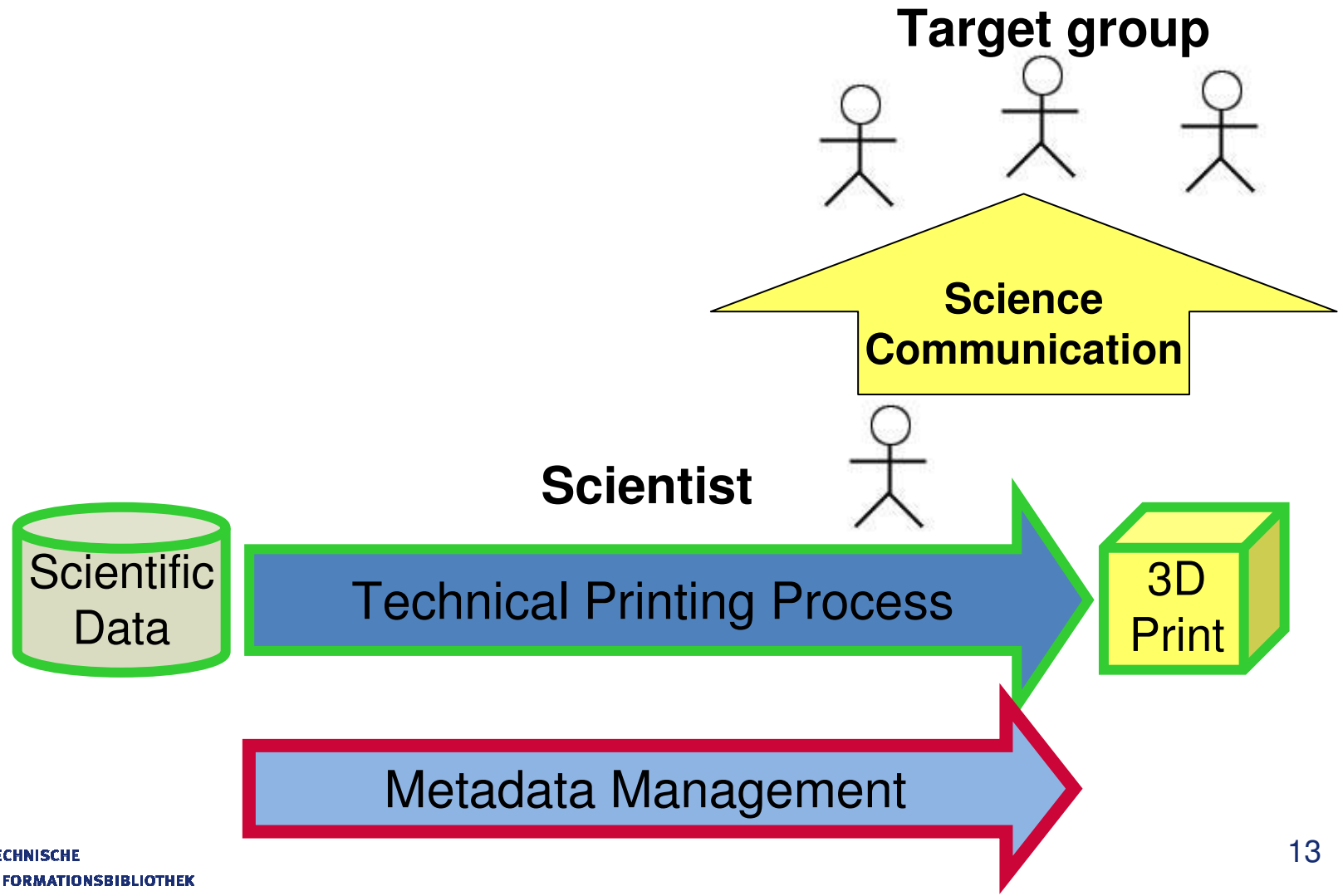


http://surveys.peerproduction.net/wp-content/uploads/2012/11/GoogleTrendsGartnerHypeCycle.png

but

- **Handpieces** for science communication
  - among scientists
  - towards the general public
- **Showpieces** for exhibitions / trade fairs
- **Condensed information** on content and quality
- **<your application goes here>**

3D printing for science communication: The larger picture



The Scientific Library perspective – Why bother ?

- This is part of an emerging trend affecting (Geo-) Science and Research, Libraries and the FOSS Communities.
- Identification, citation and preservation of scientific content needed.
- A tide of „born digital“ specimen, like 3D prints, is coming.
- Persistant identifiers are being introduced for scientific articles, data and software – and 3D prints, e.g: Digital Object Identifiers (DOI).

Libraries handle nontextual materials – including globes.

Österreichische Nationalbibliothek

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AC Globen **Suche**

Erweiterte Suche

Hinweis: Eine präzisere Abfrage führt eventuell zu weiteren Treffern.

rss
Seite dem e-Shelf hinzufügen

Ergebnisse verbessern

Thema
Erdglobus (513)
Himmelsglobus (110)
Erde <Geographie> (106)
Mondglobus (43)
Atlanten, Karten (33)
Mehr Optionen

Person/Institution
Krause, A (30)
Luther, C (28)
Neuse, R (24)
Jüttner, J (12)
Coronelli, V (11)
Mehr Optionen

Erscheinungsjahr / Datierung
Vor 1953 (529)
1953 Bis 1963 (62)
1964 Bis 1974 (60)
1975 Bis 1991 (33)
Nach 1991 (18)
Mehr Optionen

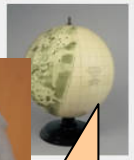
Sprache

Ergebnisse 111 – 120 von 703 für Globen sortiert nach: Erscheinungsjahr ‹ 10 11 12 13 14 ›

111 **[Himmelsglobus] : Demonstrationsmodell Horizont- und Äquatorsystem**
Bartel, Erich
Leipzig : Räth Nachfahren ; 1964
Verfügbar in: ÖNB Kartensammlung und Globenmuseum
Karte
Bestellen Standorte Details

112 **Rand Mc.Nally World Portrait Globe**
Rand McNally and Company, Chicago, Ill.
New York : Rand Mc Nally ; 1963
Verfügbar in: ÖNB Kartensammlung und Globenmuseum
Karte
Bestellen Standorte Details

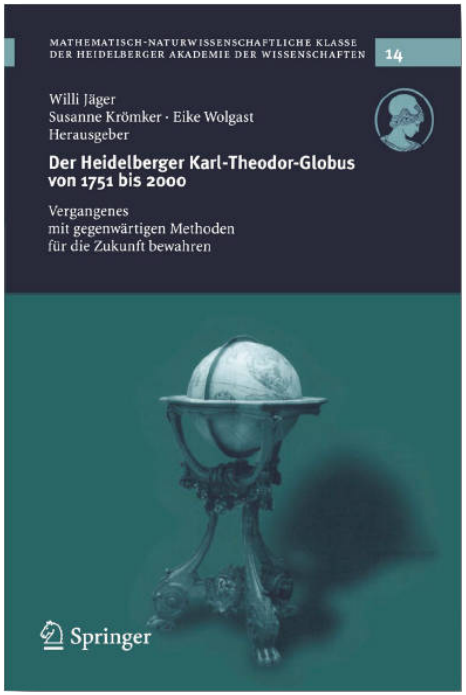
113 **Räths Mondglobus**
Leipzig : Räth Nachfahren ; 1963
Verfügbar in: ÖNB Kartensammlung und Globenmuseum
Karte



Gravity-Field-Globe

3D printed Globe

Nontextual materials: Past and present



The preservation of scientific data specimen is already part of research:

"Der Heidelberger Karl-Theodor-Globus von 1751 bis 2000
Vergangenes mit gegenwärtigen Methoden für die Zukunft bewahren"

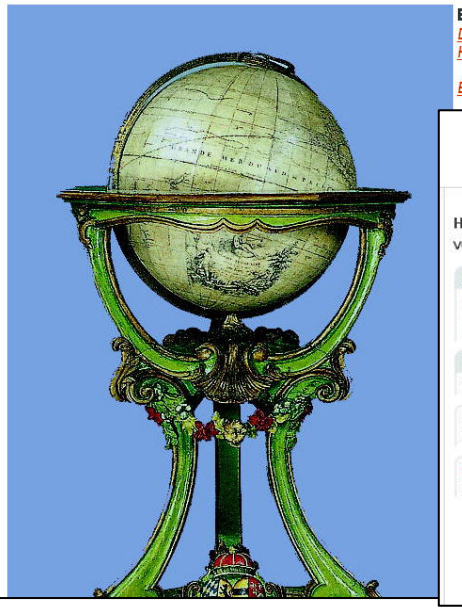
Linking research articles, data and 3D objects: Important for researchers … and research-based libraries

Digitale Restaurierung der Kupferstiche des Heidelberger Globus von 1751

Der Heidelberger Karl-Theodor-Globus, der derzeit in der Ausstellung ***Kostbarkeiten gesammelter Geschichte*** in der Universitätsbibliothek zu sehen ist, wurde auf Anordnung des französischen Königs und mit Genehmigung der königlichen *Académie des Sciences* im August 1751 gefertigt. Die Kartographie wurde von Guillaume de la Haye gestochen. Hergestellt wurde der Globus in der Werkstatt des französischen Kartenmachers Didier Robert de Vaugondy (1723 - 1786).

Kurfürst Karl-Theodor (1724-1799) orderte diesen Globus und das Pendant eines Himmelsgobus für seine Mannheimer Bibliothek.

In unserer Arbeitsgruppe *Visualisierung und Numerische Geometrie* am *Interdisziplinären Zentrum für Wissenschaftliches Rechnen* wurden die Papiersegmente mit Methoden der digitalen Bildverarbeitung restauriert. Dazu finden Sie auf den folgenden Seiten eine Beschreibung und Bebilderung.



Beschreibung

Digitale Restaurierung des Heidelberger Globus

Beteiligte Personen

Wiley Online Library

TIB/UB Hannover | Log in / Register

Home > Information Science & Technology > Information & Library Science > Universitätsbibliothek Heidelberg: Ordnung und System: Festschrift zum 60. Geburtstag von Hermann Josef Dörpinghaus > Summary

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For Authors

Chapter 18. Ein Globus für den Kurfürsten Karl-Theodor

Dr. Gisela Weber

Jens Dannehl

DOI: 10.1002/9783527624782.ch18

Book Title

Universitätsbibliothek Heidelberg: Ordnung und System: Festschrift zum 60. Geburtstag von Hermann Josef Dörpinghaus

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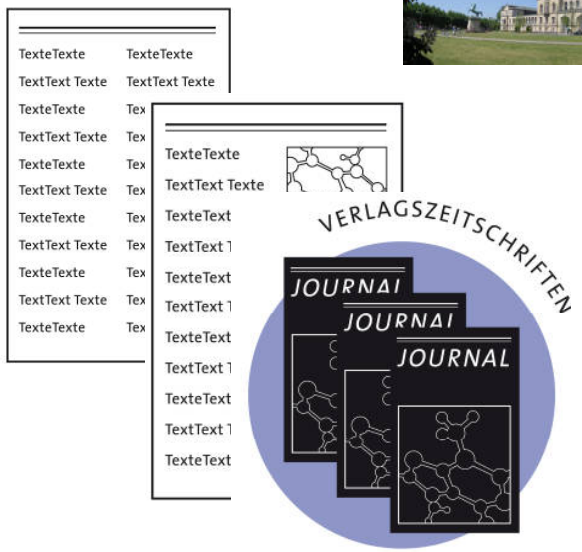
ISBN Information

Digital Object Identifier (DOI)

Technische Informations Bibliothek (TIB)
German National Library of Science and Technology

Global supplier for scientific and technical information



Traditional text-based documents

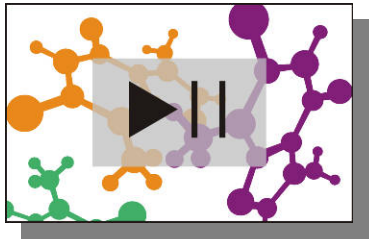
TIB – German National Library of Science and Technology - Today

GetInfo Portal

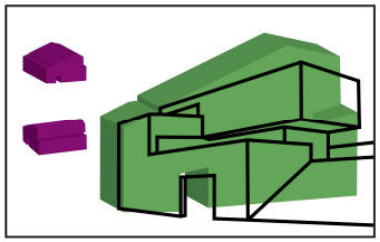
- **57 Mio. metadata** indexed with access to the fulltext (document delivery, national licences, pay-per-view)
- **160 Mio. documents** available via metasearch

Strategy – Move beyond text

Software

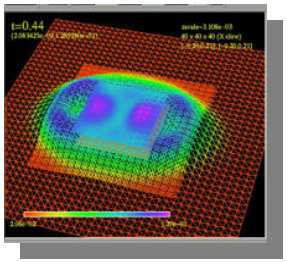


Scientific Films

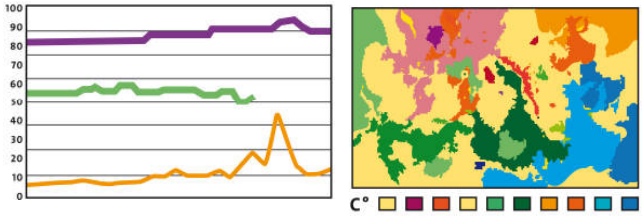


3D Objects

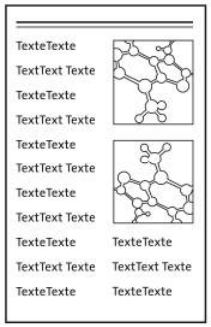
TIB



Simulation



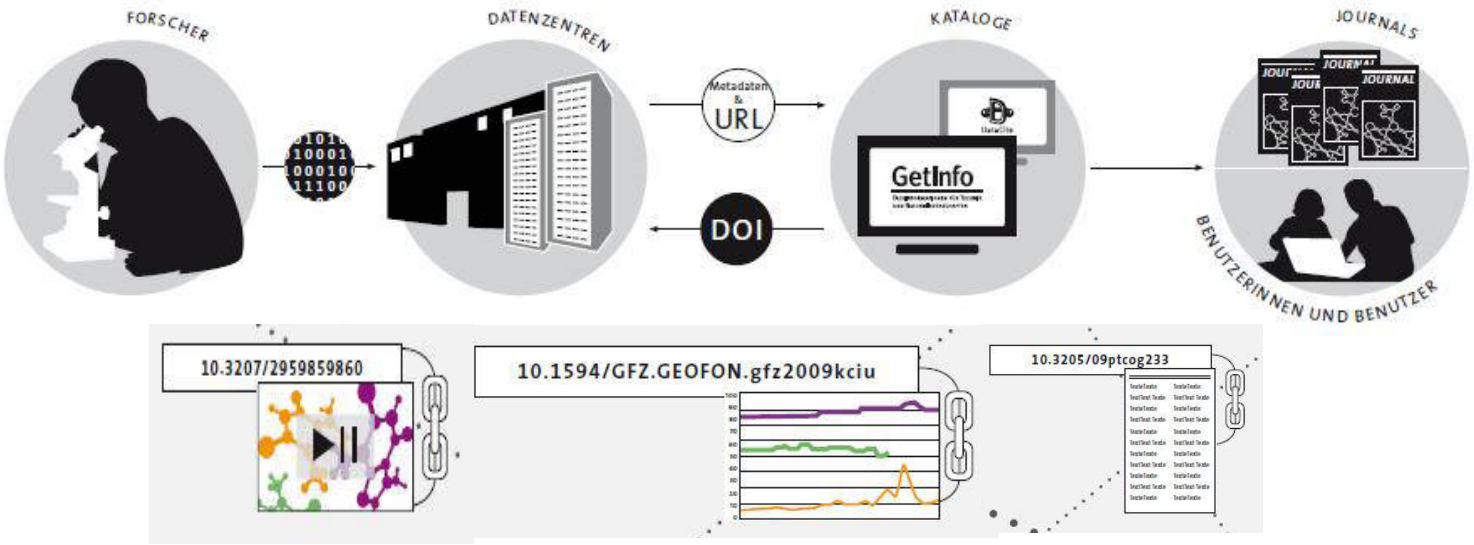
Research Data



Text

TIB – German National Library of Science and Technology - DOI

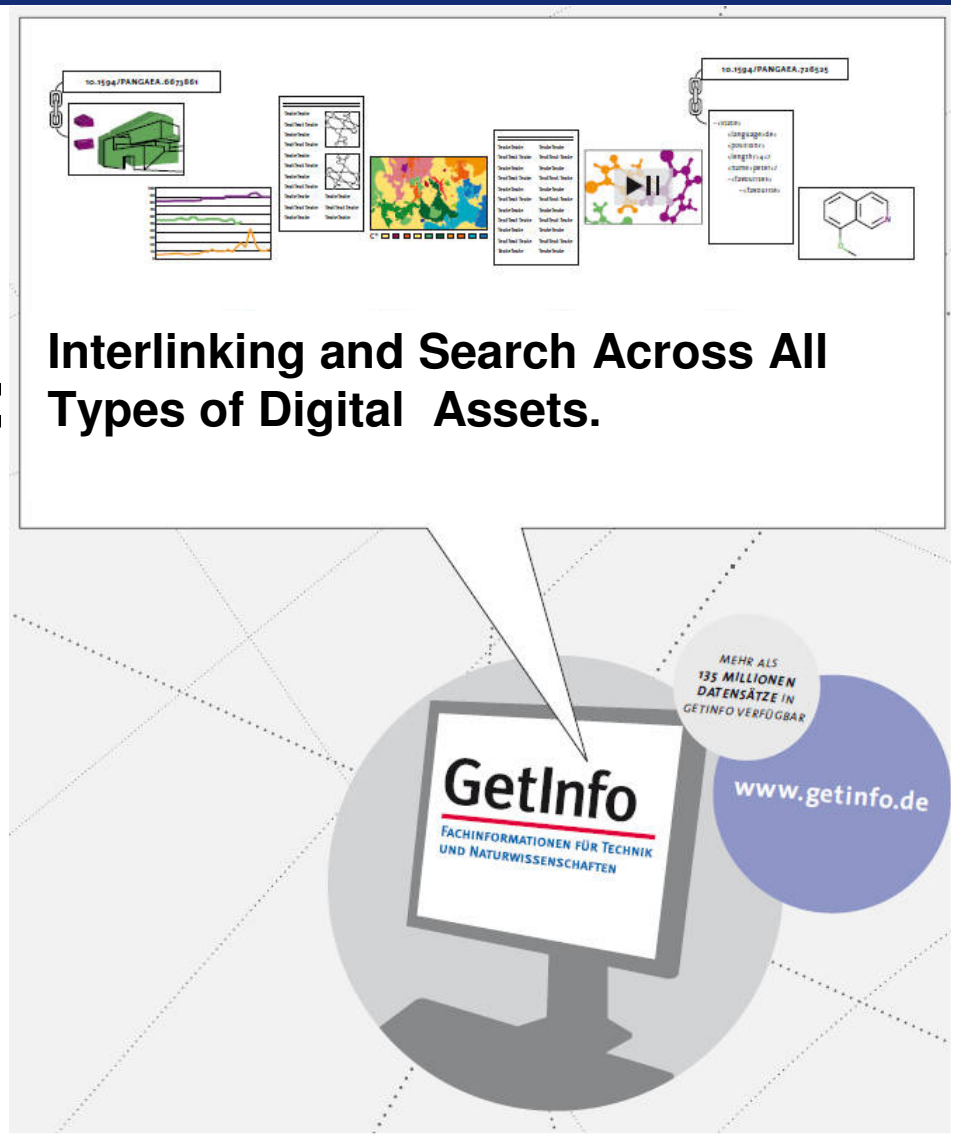
• **Worldwide first Digital Object Identifier (DOI) registration agency** for datasets (since 2005)



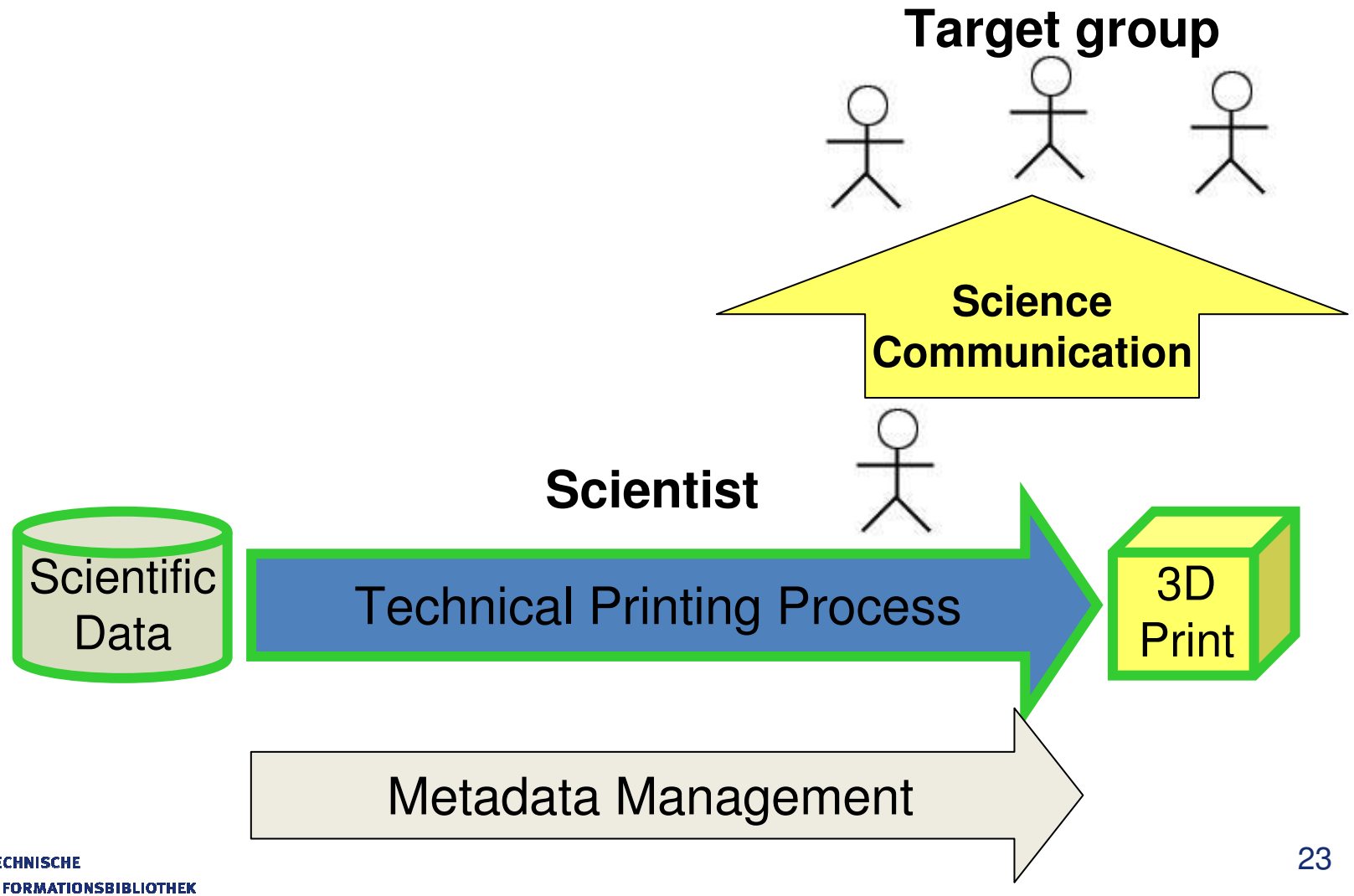
DataCite
International Data Citation

The road ahead
– the research library perspective

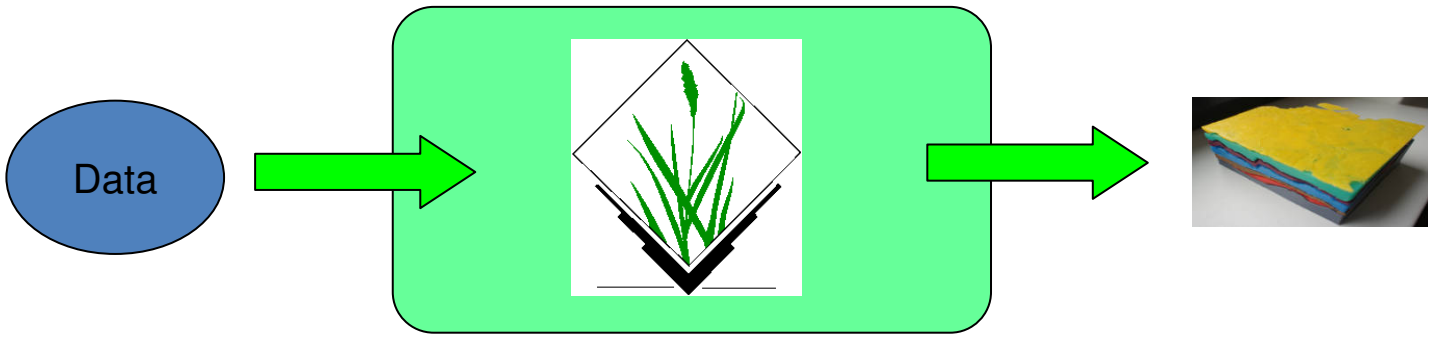
Ultimate Goal:



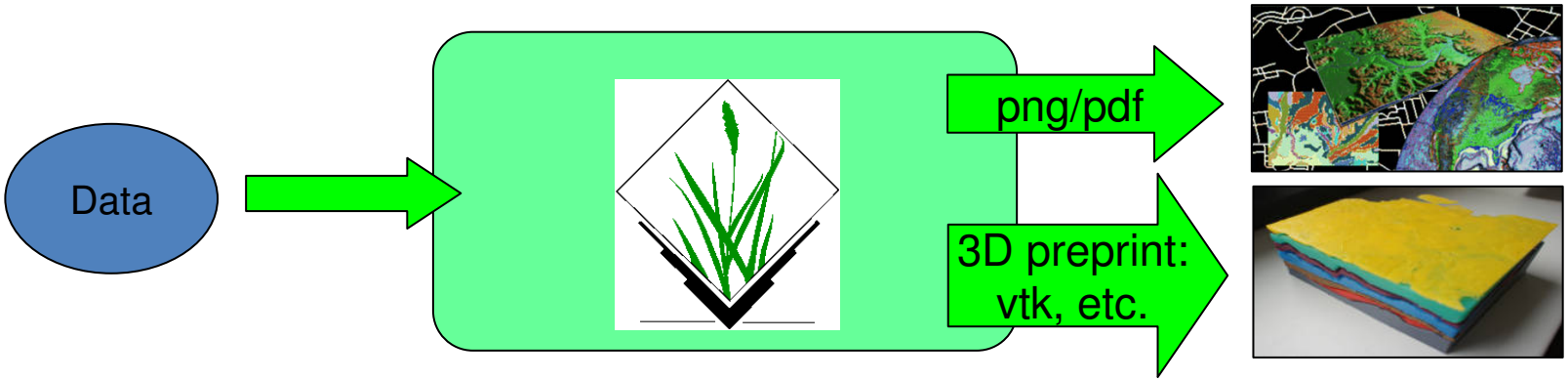
3D printing for science communication: GRASS GIS angle



Technical overview

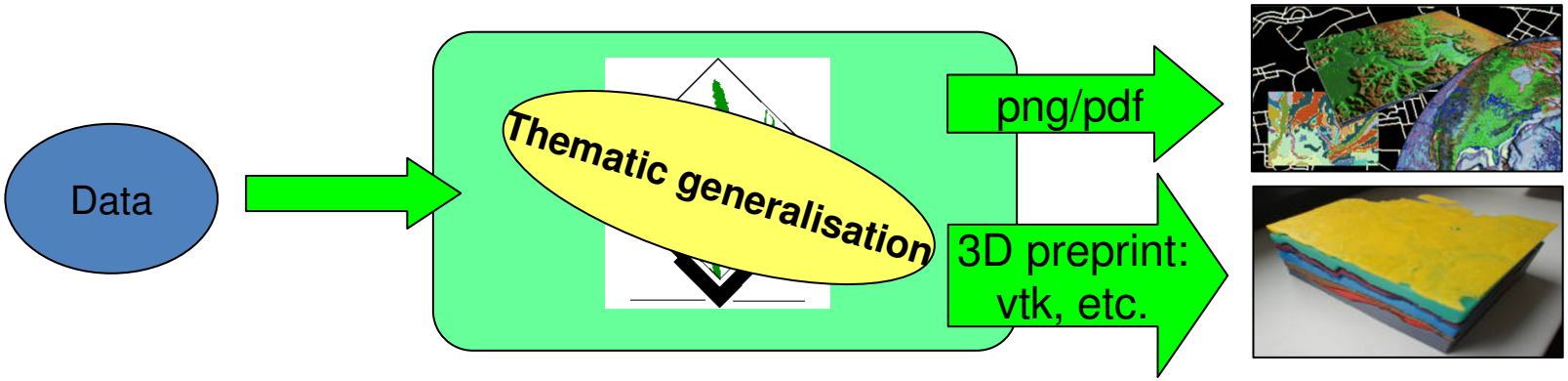


Technical overview



3D preprints - just a gdal/ogr extension ?

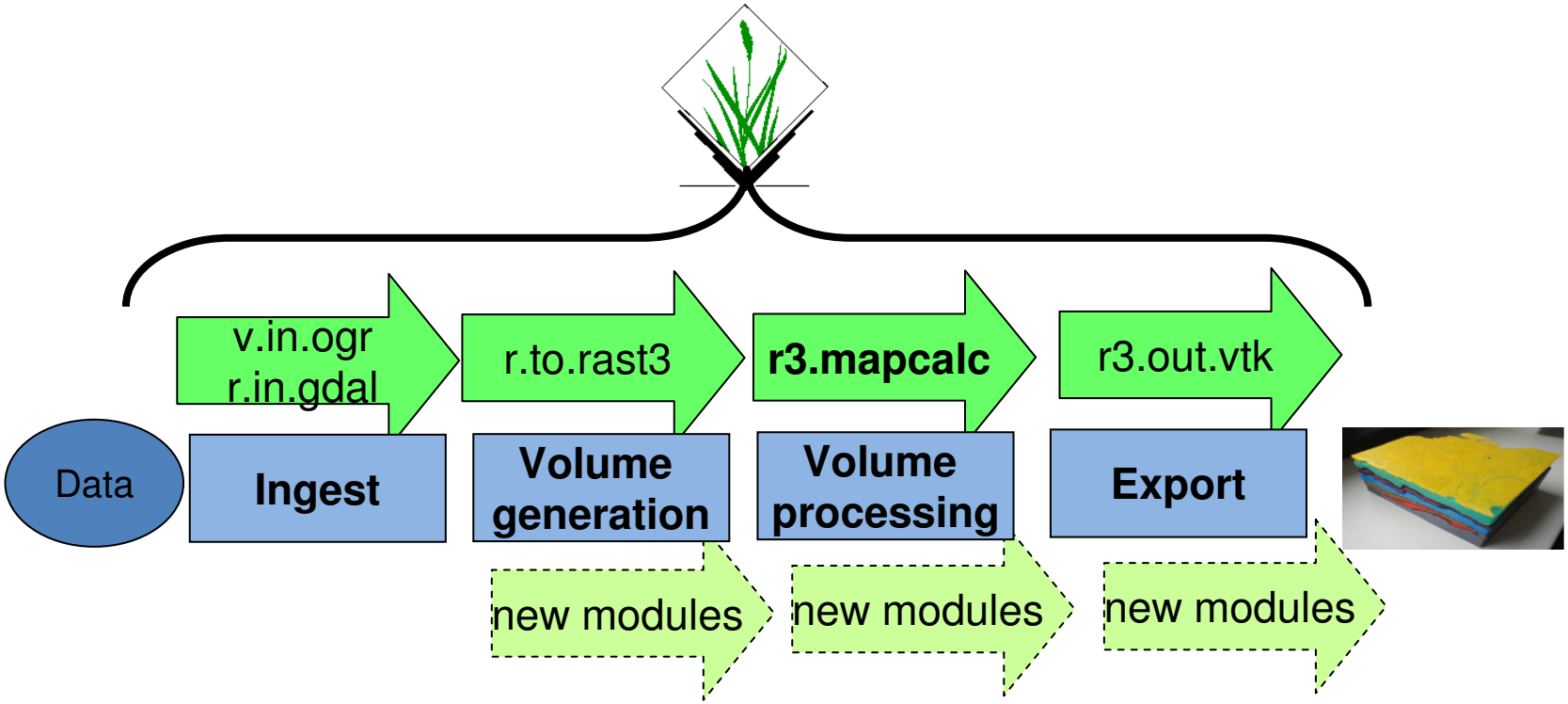
Technical overview



3D preprints - just a gdal/ogr extension ?

Thematic generalisation is needed: **r3.modules**

Technical overview: Current situation

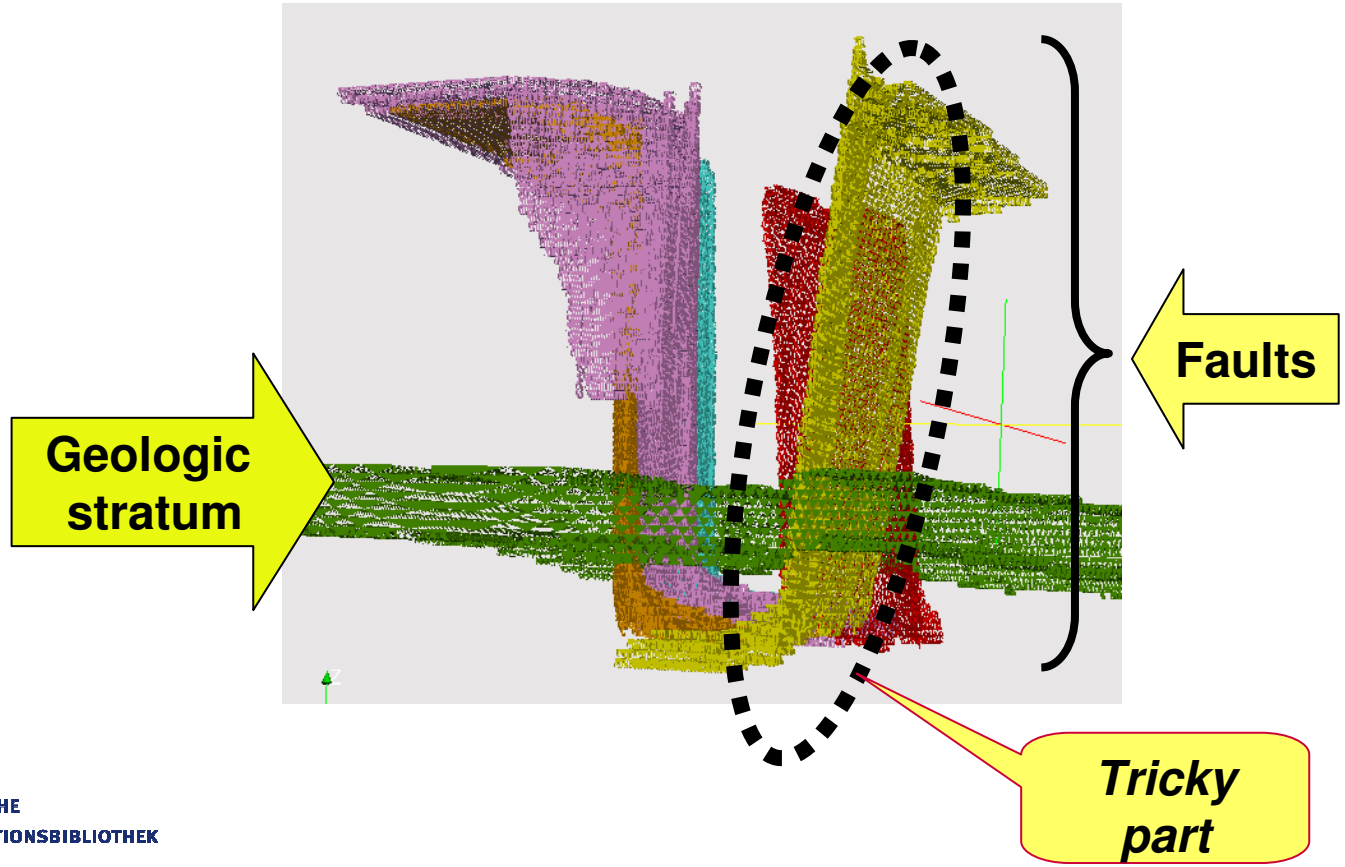


Wanted: 3D print workflow trailblazers !

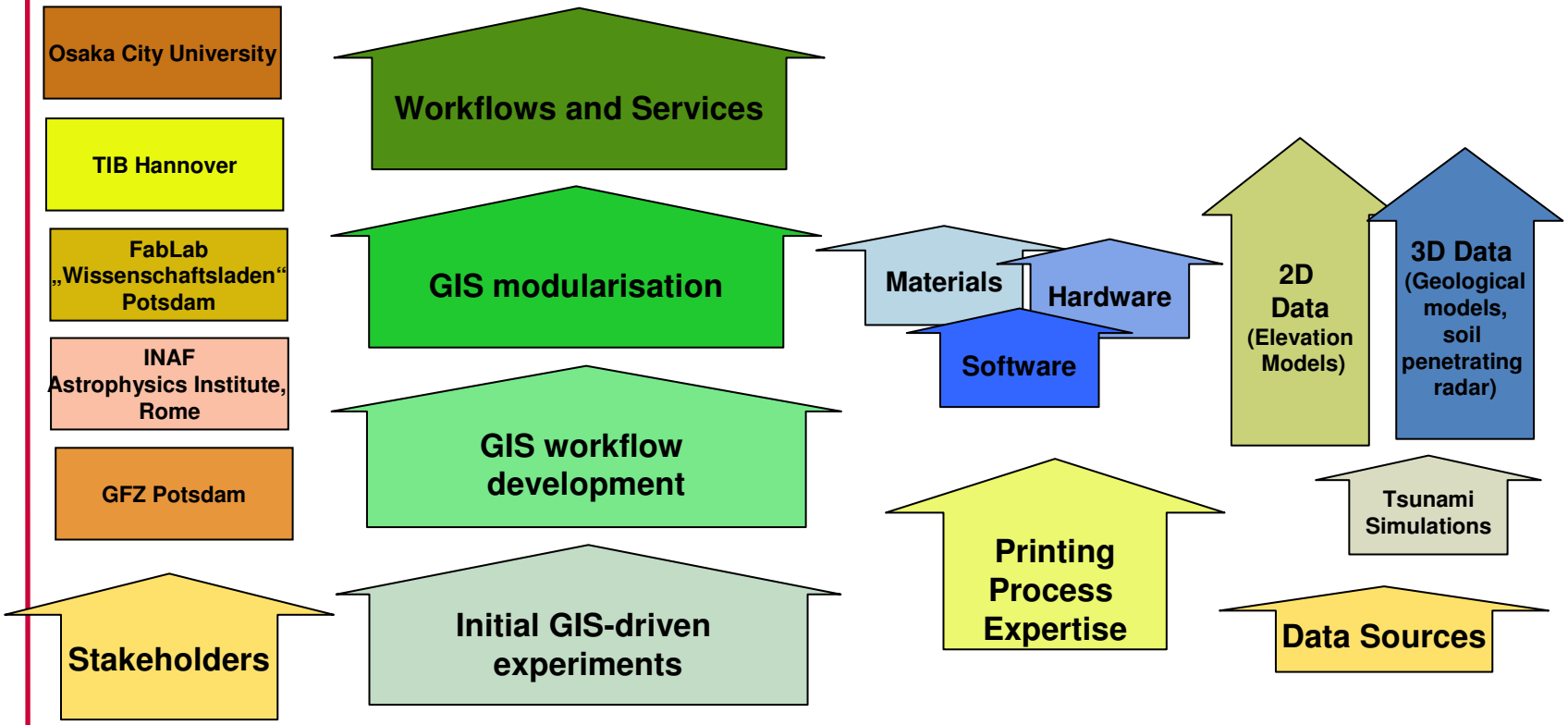
- Volume generalisation with r3.x-modules requires currently these skills:
  - **Science Interpreter/Communicator:** „What message to convey ?“
  - **Technical/Software:** create workflows in r3.mapcalc, script these
  - **Admin/Pioneer:** be able to install patches for GRASS7 due to bugs (volume-related), help improve code maturity

Example: Thematic generalisation with r3.mapcalc

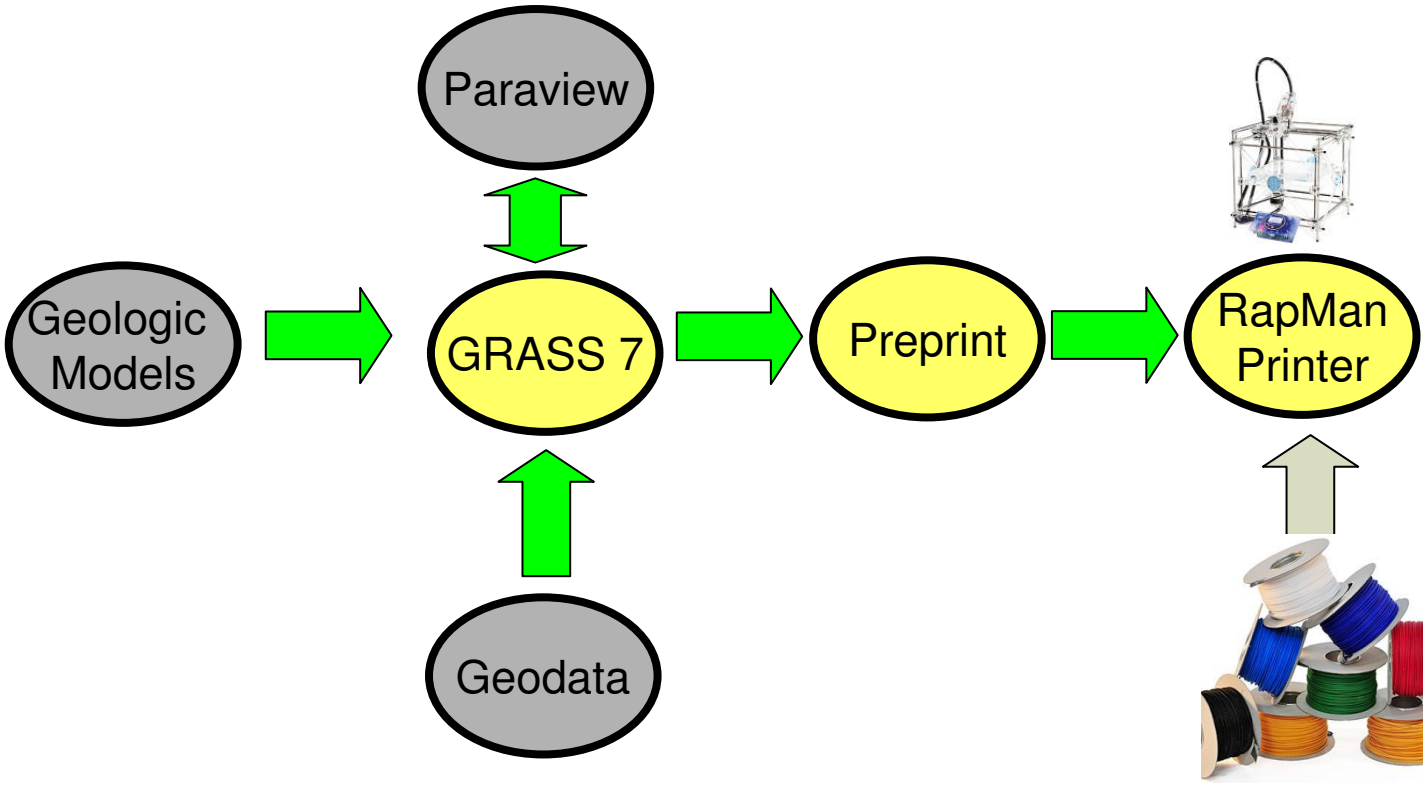
- Task: Separation of geologic volumes along complex faults („cutting pane“)
- Requirement: Volume hulls must be continuous (no holes).
- Solution: „Growing“ of fault lines into cutting panes with r3.mapcalc.



Multiple linked learning processes



Processing:
Software tools and formats



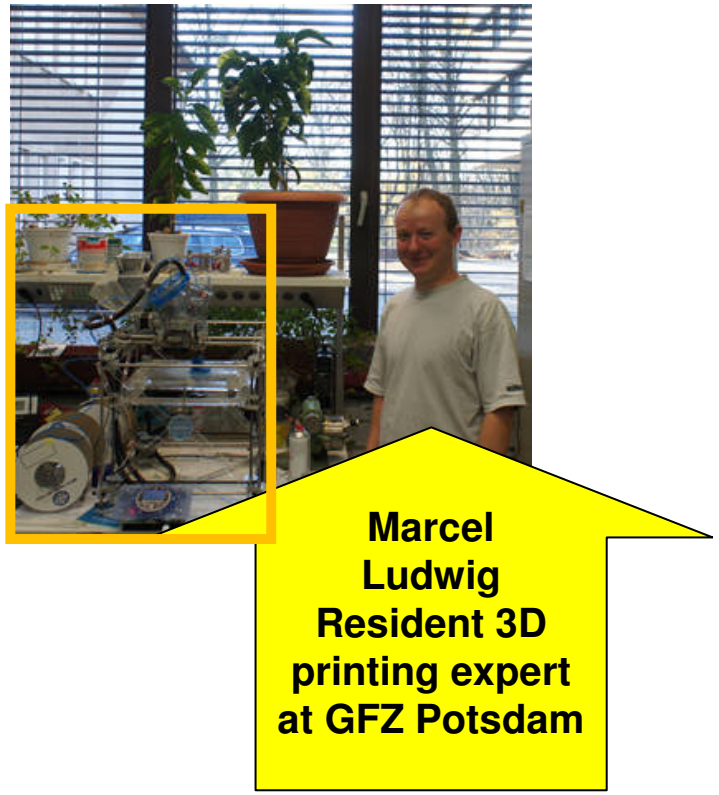
Hardware example:
RapMan 3.2 3D printer

RapMan 3.2: Reality check

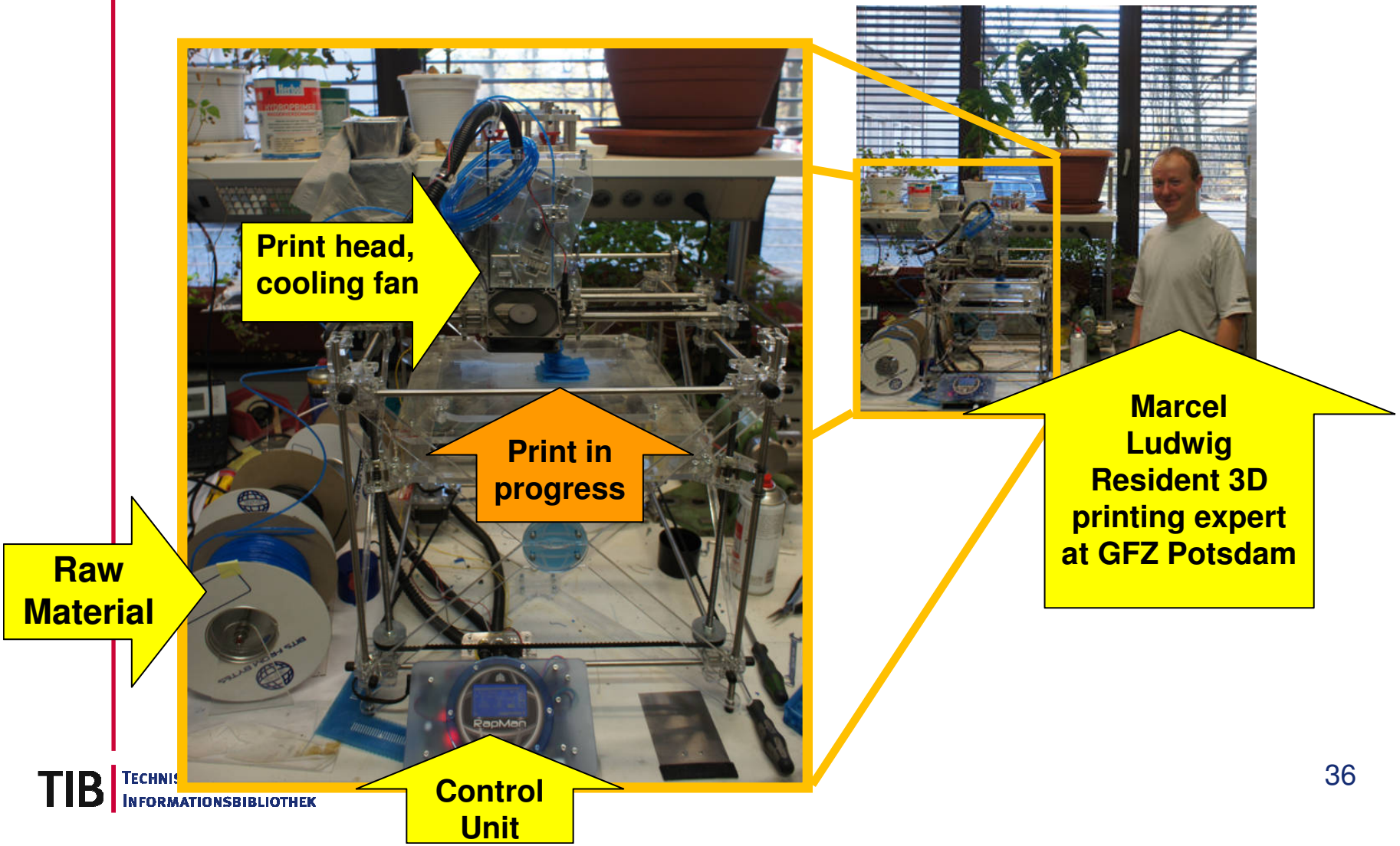
RapMan 3.2: Reality check

Marcel Ludwig Resident 3D printing expert at GFZ Potsdam

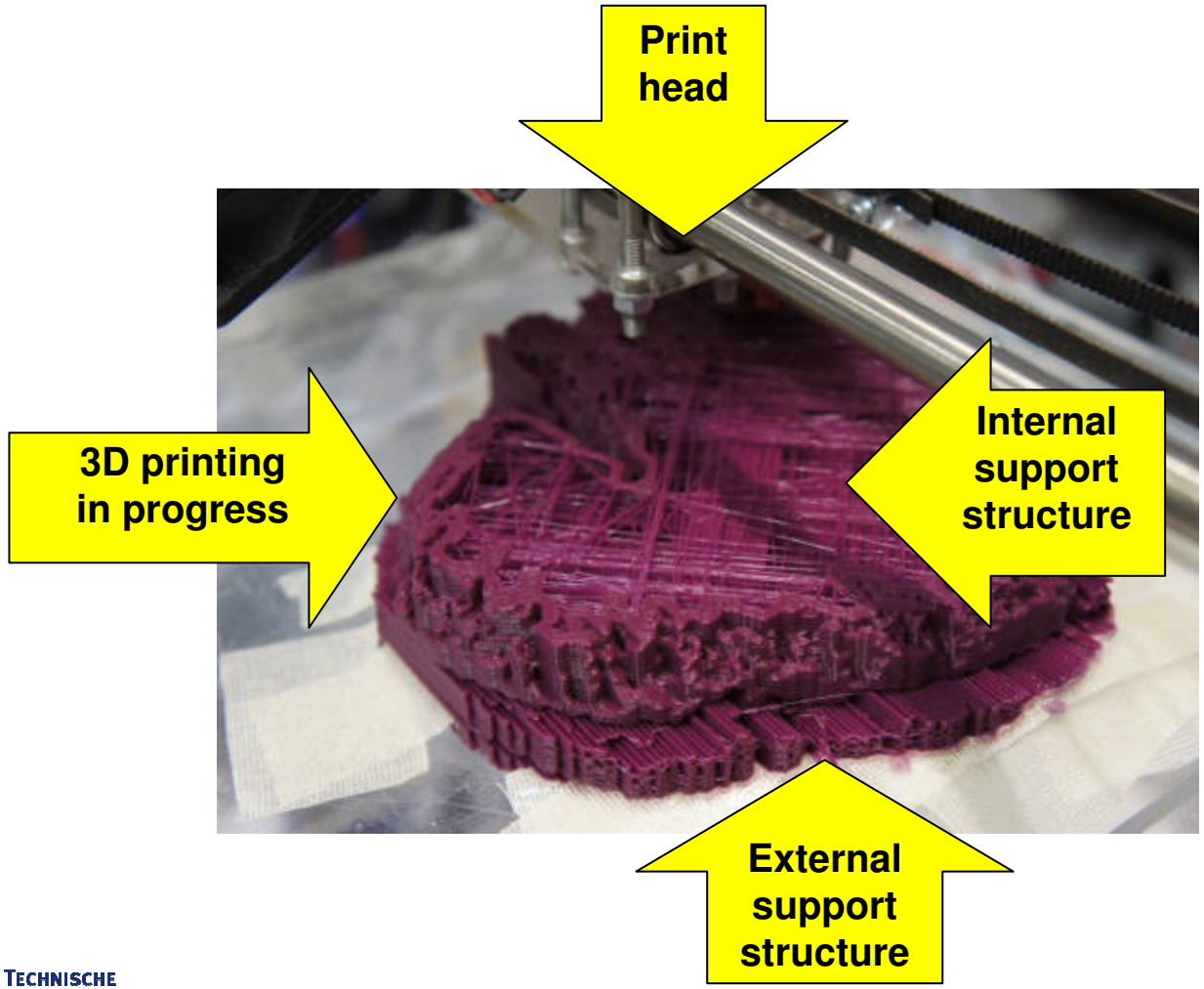
RapMan 3.2: Reality check



RapMan 3.2: Reality check



Close-Up: Actual printing

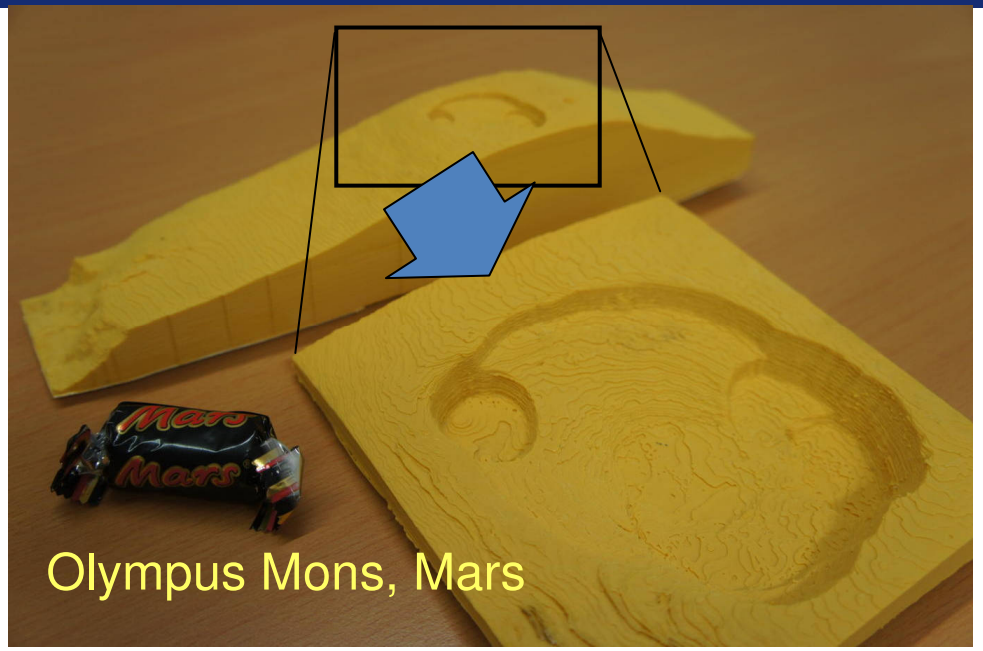


Application examples

Elevation models

More elevation models

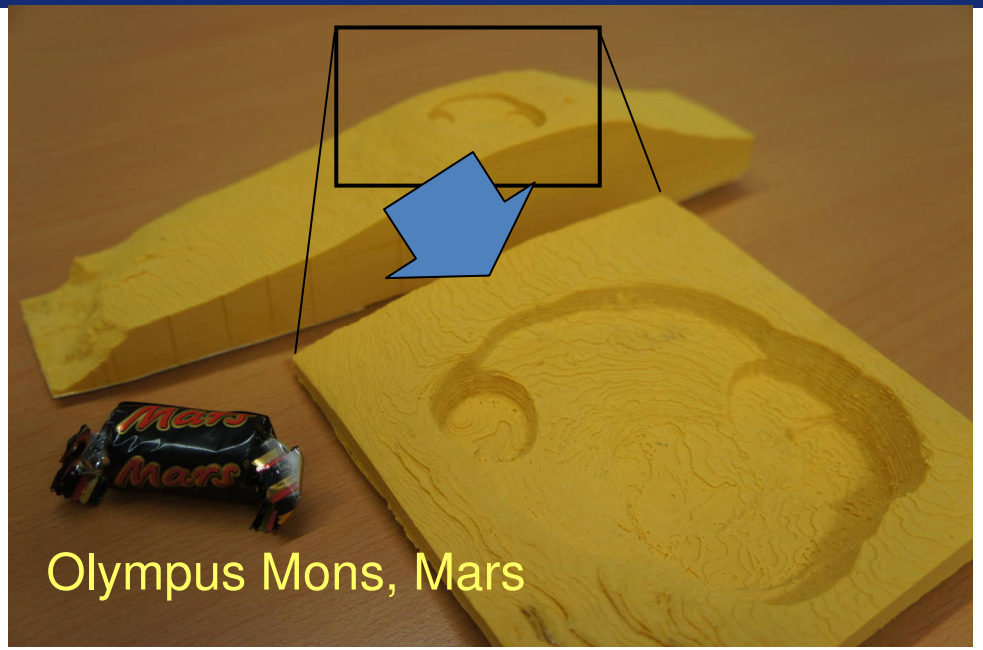
More elevation models



More elevation models

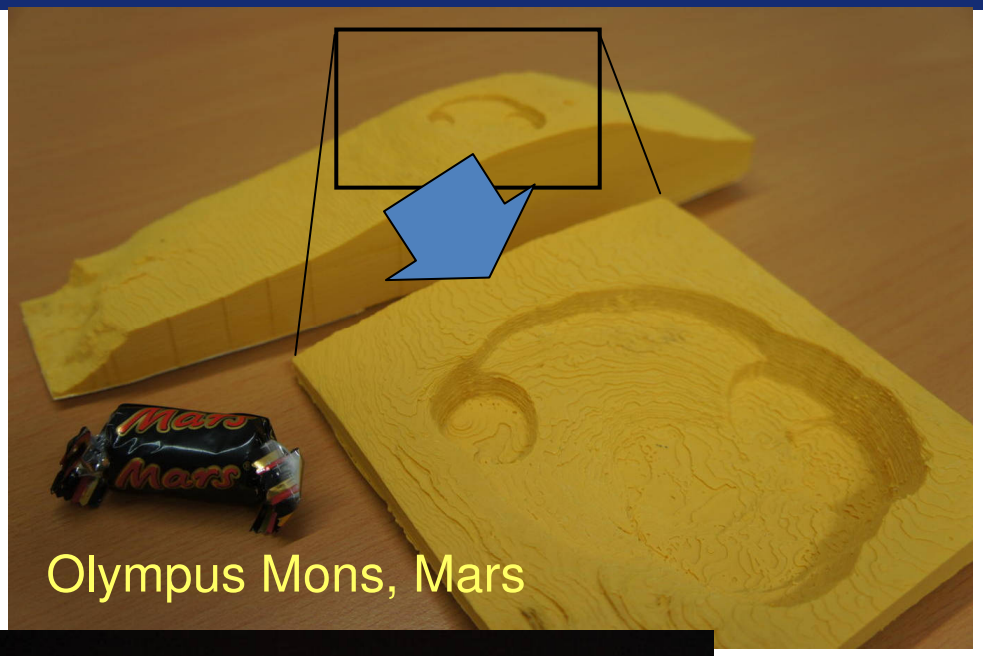

Mekong River Catchment

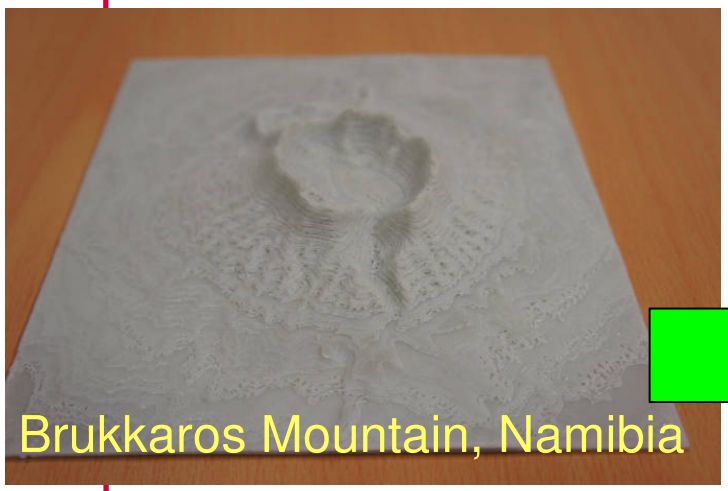

Brukkaros Mountain, Namibia



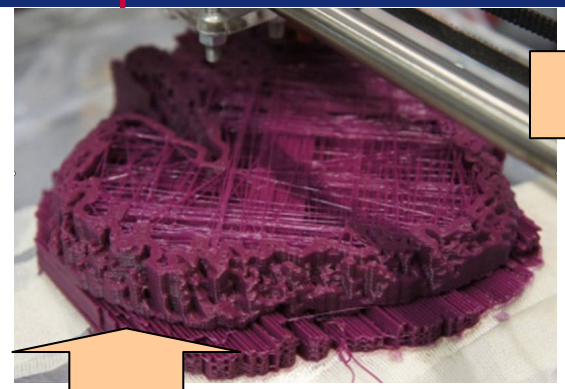
Olympus Mons, Mars

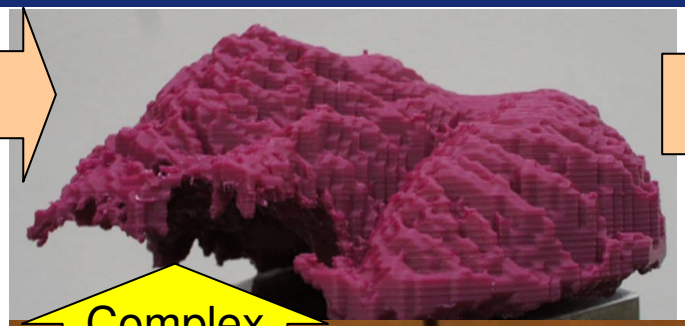
More elevation models





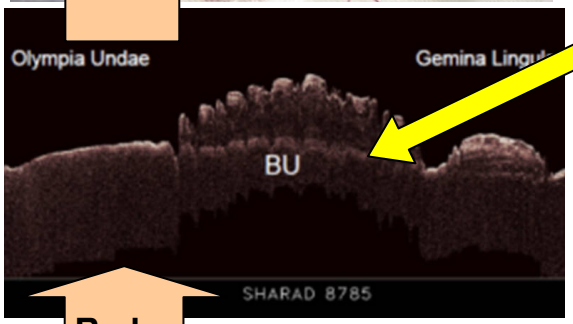
Mars north polar cap / satellite-based ground penetrating Radar





Images:
GFZ Potsdam,
INAF

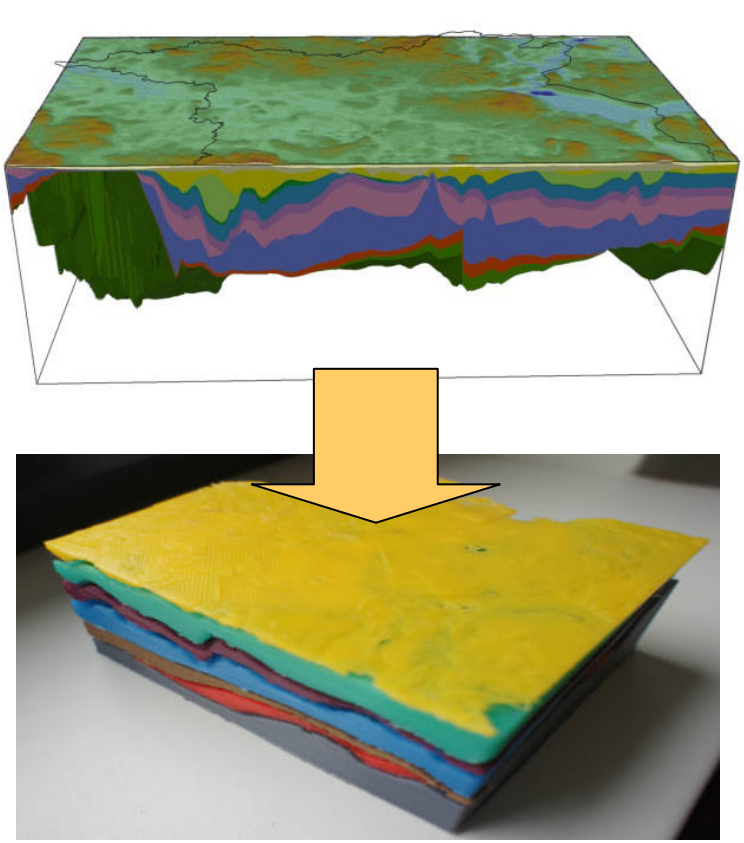
Complex underside

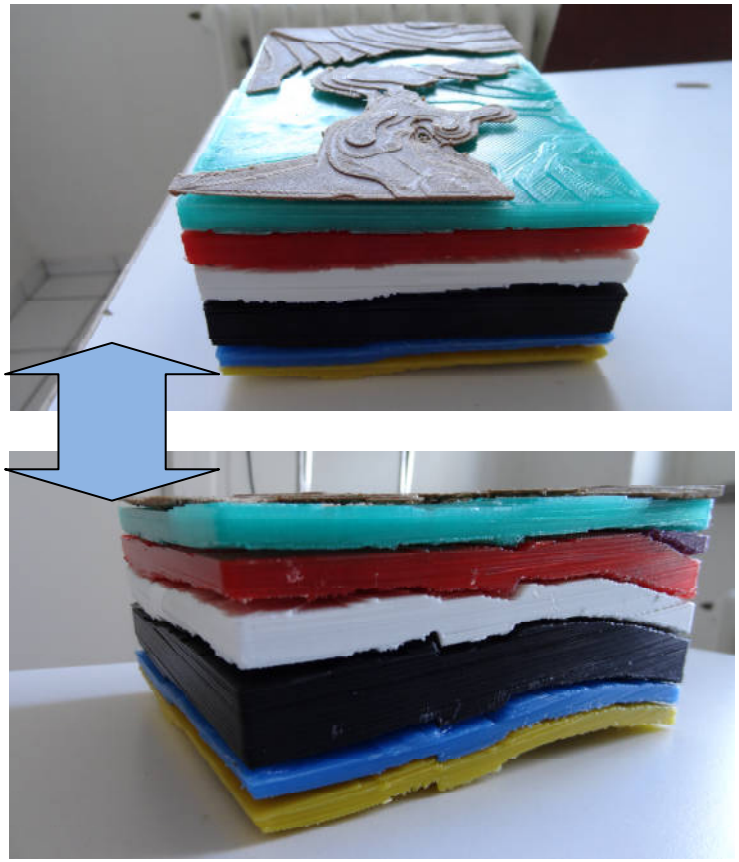


Radar

Alessandro Frigeri, INAF, 2012

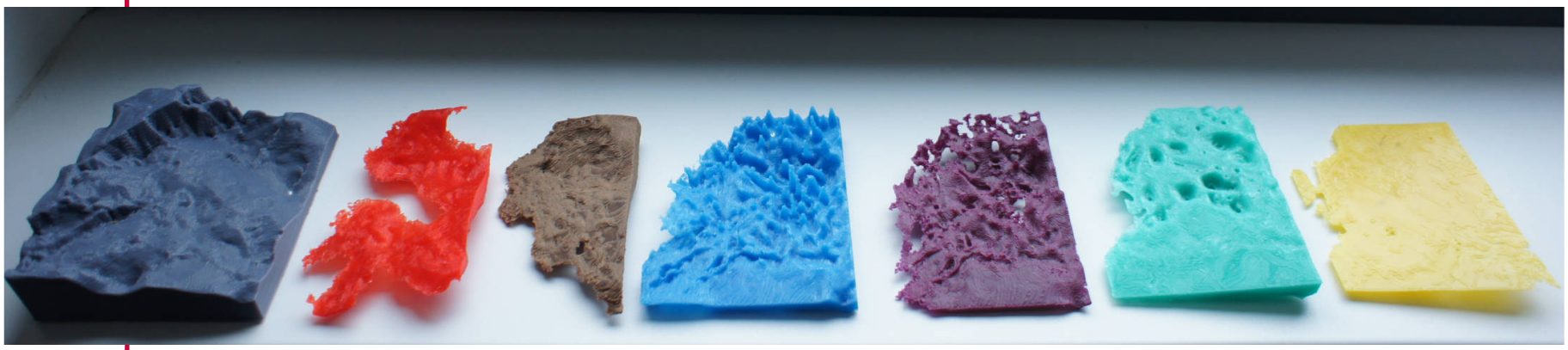
Layer stacks of 3D bodies (Geology)

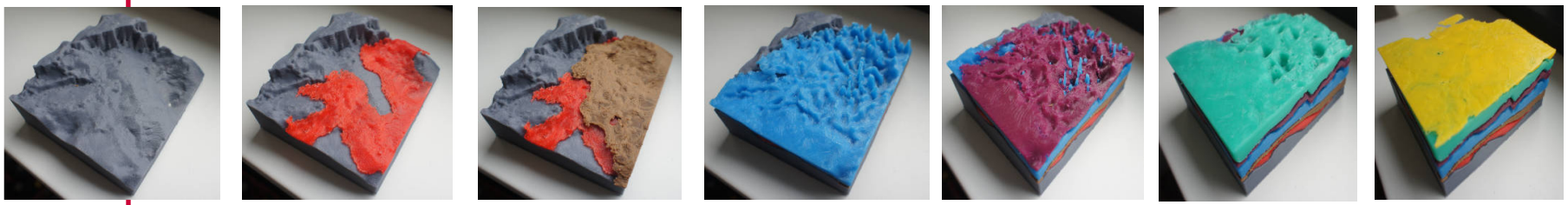




Images: GFZ Potsdam

Close-up: Geologic volume stack example

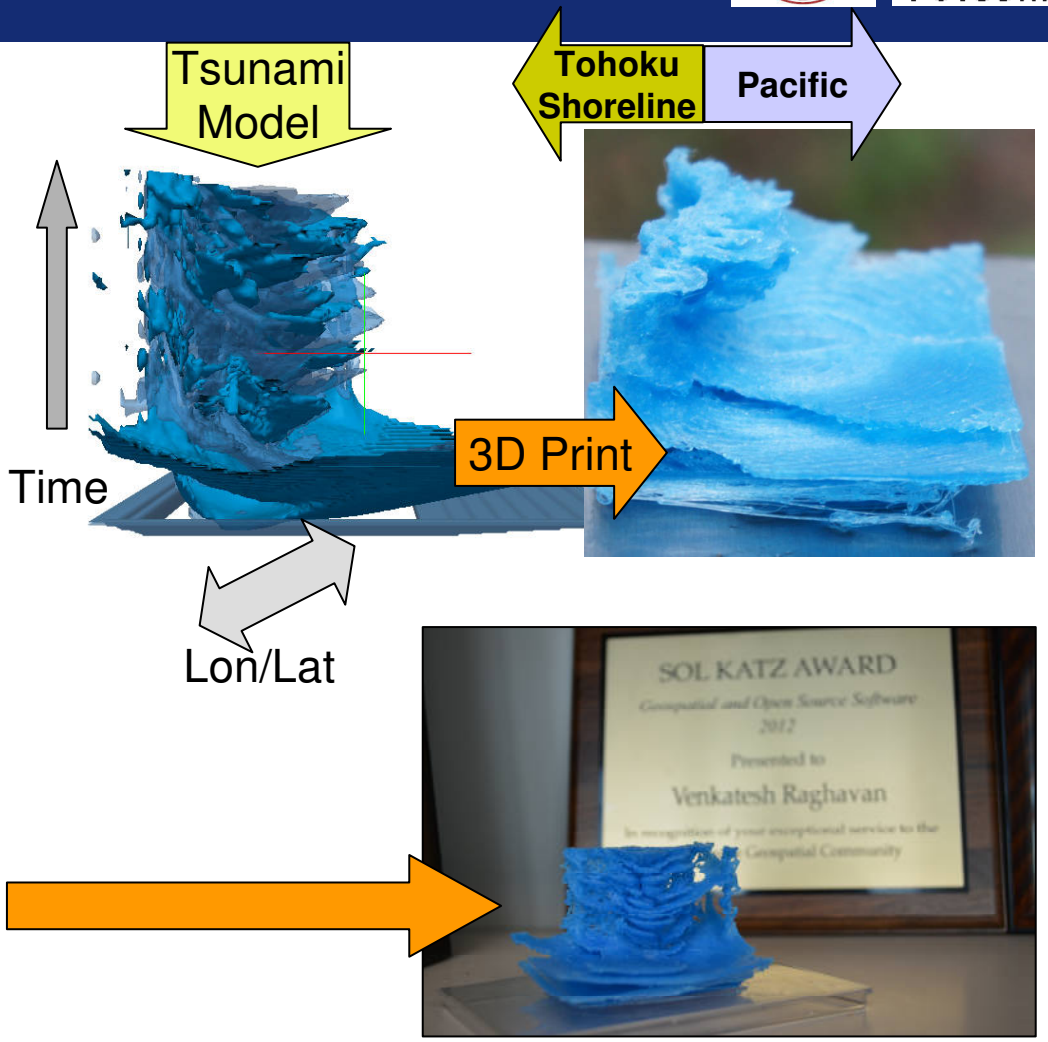




Images: GFZ Potsdam

Complex data sets:
Tsunami propagation space-time-cubes

- Space Time Cube (STC) of tsunami wave propagation.
- Complex wave propagation in time and space.
- Allows visual model quality assessment.
- Produced by GFZ Potsdam in 2012.
- On permanent display at the Osaka City University (2014)



Recap: But there‘s more to it..

- Interfacing GRASS GIS with 3D print workflows can already done with the current GRASS modules.
- Prediction: Easy to use GRASS extensions for 3D printing will come soon.
- Scientific 3D Prints extend „flat“ 2D science communication
- Decelerated haptic data access (no-display-needed)
- **Large potential for science communication**
- **The bigger picture of Open Science: Open Data, Open Source, DOI**
- **Thematic generalisation via r3.x – modules.**

- **Much more coming**

Freely available geologic data sources ?
The situation is improving

Main

Open Seismic Repository

Free and public data sets are available for download below. We are looking for more surveys to make available.

Download Free Seismic Surveys [Torrents]

- Netherlands Offshore F3 Block Complete 4 GB
  Data Summary: 3D Seismic Data, Acoustic Impedance, Wells, Horizons
- Netherlands Offshore F3 Block Seismic Only 494 MB
  Data Summary: 3D Seismic Data, Wells, Horizons
- Laurentian Basin Canada Complete 2 GB
  Data Summary: 2D Data (29 lines)
- USGS Central Alaska Seismic Only 264 MB
  Data Summary: 2D Data (17 lines)
- Penobscot 3D Survey (Complete Pre-stack data is also available)
  Data Summary: 3D Seismic data, Prestack 3D data, Wells, Horizons
- Blake Ridge Hydrates 3D 914 MB
  Data summary: 3D PSTM volume offshore South Carolina with gas hydrates

http://opendtect.org/

Main

Netherlands Offshore F3 Block - Complete

Download Torrent

Download The 'stacking velocity function' for time-depth conversion exercise!
Right click on the link and Save the link as *Velocity_functions.txt*

General

Country:	The Netherlands
Location:	Offshore, NorthSea
Block:	F3
Coordinates:	N 54°52'0.86" / E 4°48'47.07 view in Google Earth
Year:	1987
Data Summary	3D Seismic Data, Acoustic Impedance, Wells, Horizons
Size:	9.15 GB (uncompressed), 5.71 GB (download)
License:	(cc) BY-SA

Contributor

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GFZ Helmholtz Centre Potsdam

Thanks for listening
Have a great FOSSGIS 2014 !

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