Digital Silk Road: Toward Digital Survey of Dunhuang Mogao Caves

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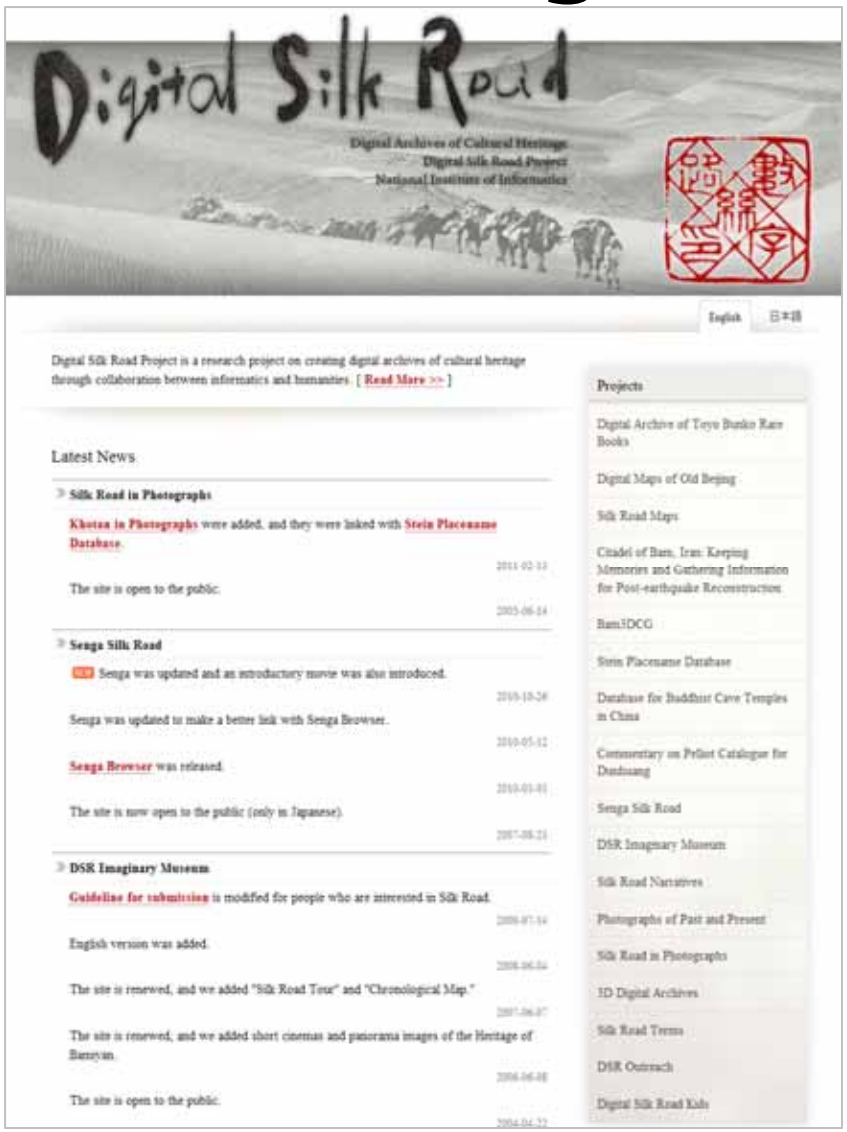
http://dsr.nii.ac.jp/

2011 Dunhuang Forum:
International Conference on Cultural Heritages and Digitization

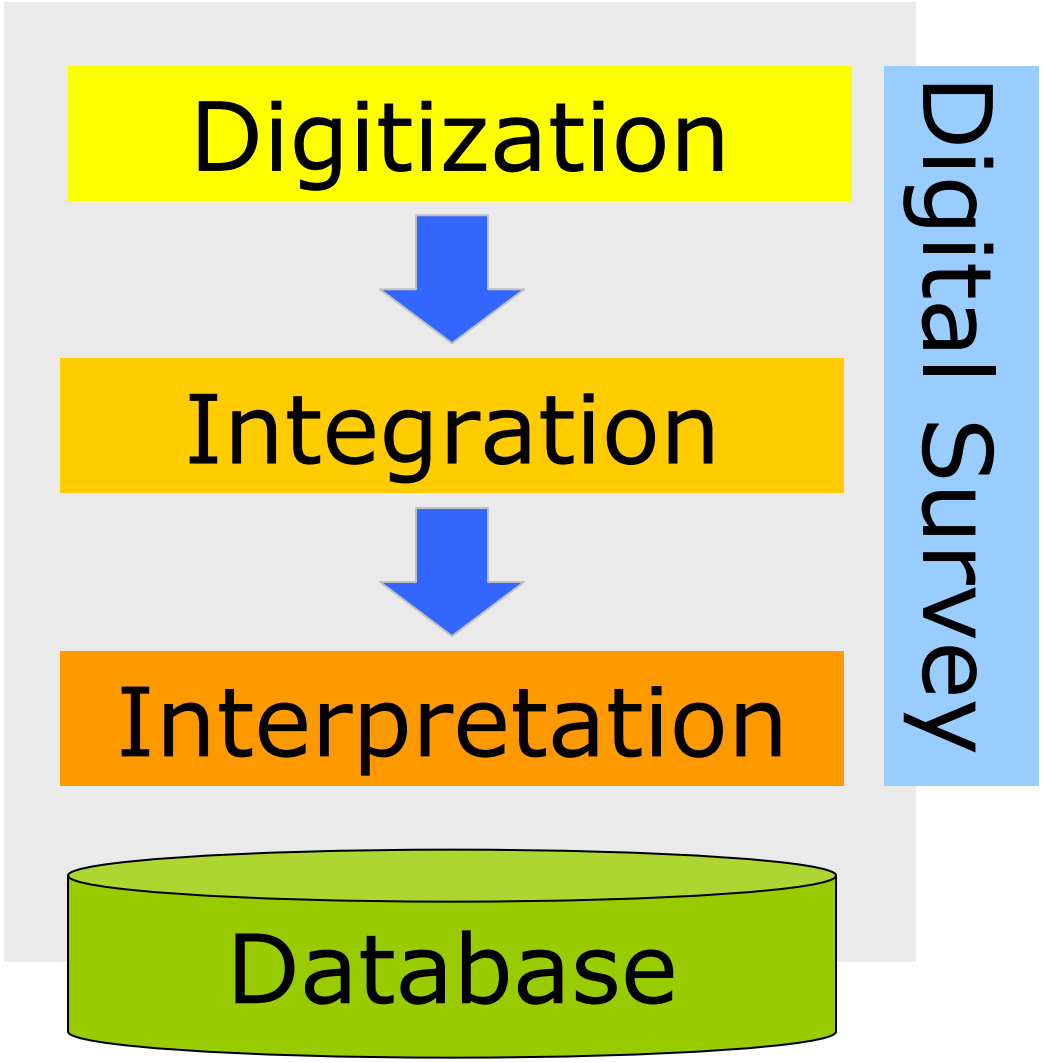
Digital Silk Road



- Started in 2001.
- Collaborative work between informatics and humanities.
- Digital humanities (data-centric) approaches to Silk Road studies.
- 10+ sub-projects.

http://dsr.nii.ac.jp/

Digital Humanities

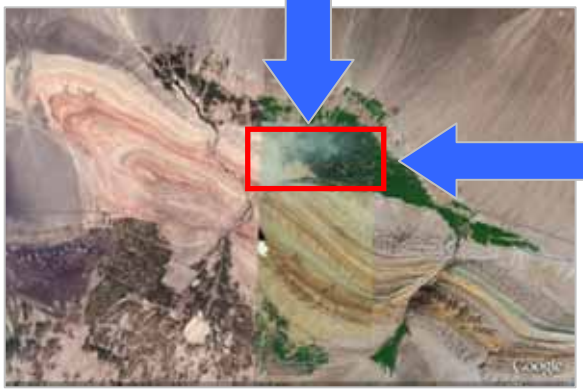


- Massive data changes the way of humanities research.
- Database supports digital survey of massive data.
- Digital survey reveals hidden relationships.

Digital Survey

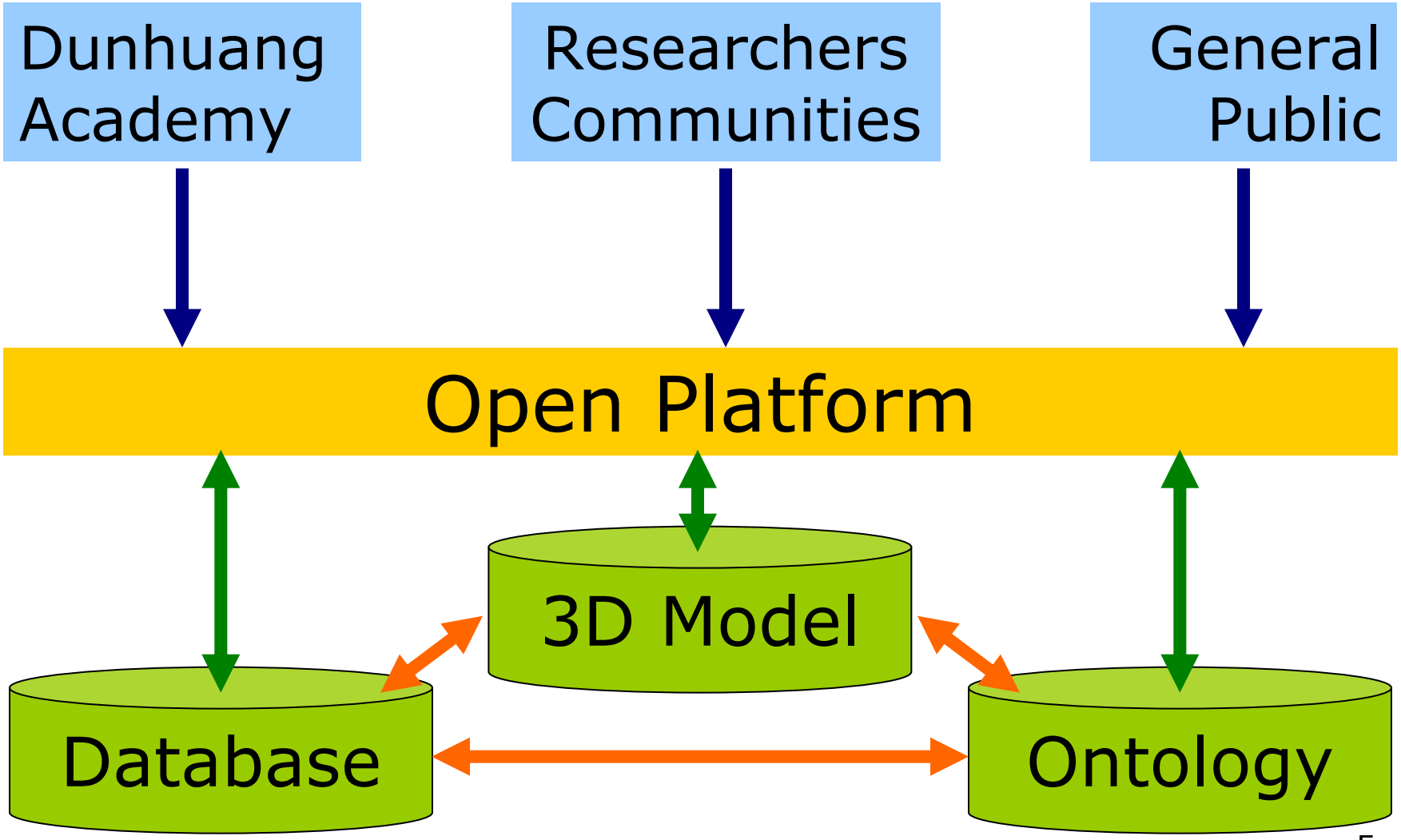
Tschyqqan(Čïqqan)Köl

Linking Resources

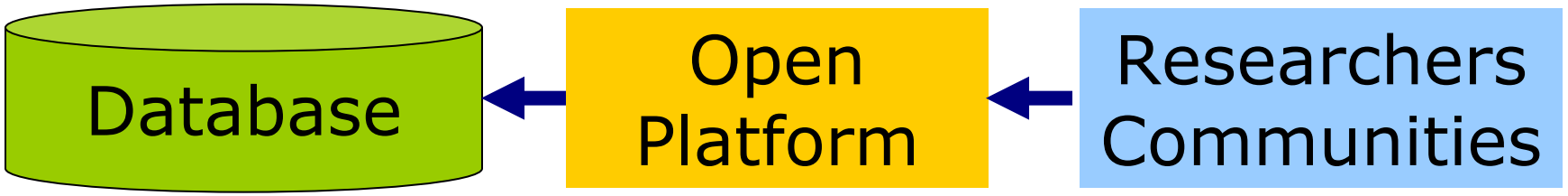


Apply the digital survey approach to Dunhuang?

Digital Dunhuang?



Current Progress



- **NII-Toyo Bunko Digital Archive of Rare Books**
  - Collaboration with Toyo Bunko
- **Database of Buddhist Cave Temples in China**
- **Commentary on Pelliot Catalogue for Dunhuang**
  - Collaboration with Dunhuang Academy and Lanzhou University

NII-Toyo Bunko
Digital Archive of Rare Books

- 116 books, 30000 pages of Silk Road academic books.
- Selection based on quality rather than quantity.
- OCR for full-text search (error not corrected).

http://dsr.nii.ac.jp/toyobunko/

Digitized Books

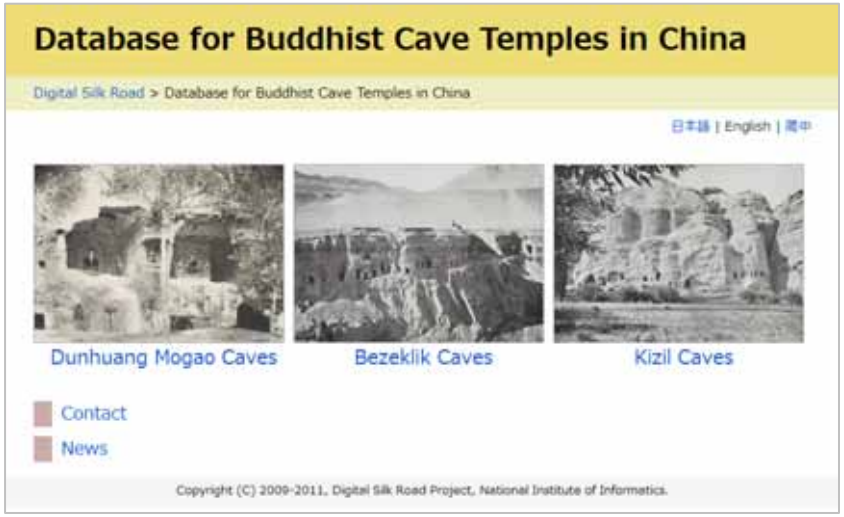
Dunhuang Mogao Caves

- M. A. Stein, *Serindia*
- P. Pelliot, *Les Grottes de Touen-houang*

Bezeklik, Kizil, ...

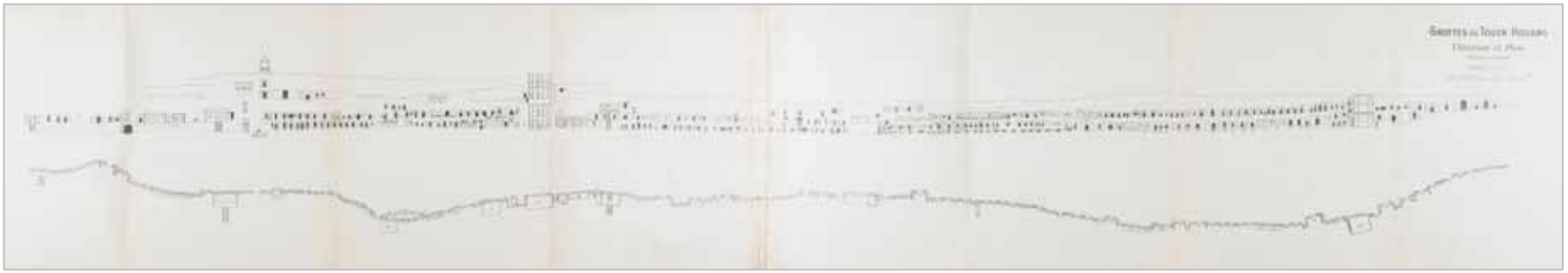
- A. Grünwedel, *Alt Kutscha*
- A. Grünwedel, *Altbuddhistische Kultstätten in Chinesisch-Turkistan*
- A. Le Coq, *Chotscho*
- A. Le Coq, *Die Buddhistische Spätantike in Mittelasien*

Database of Buddhist Cave Temples in China

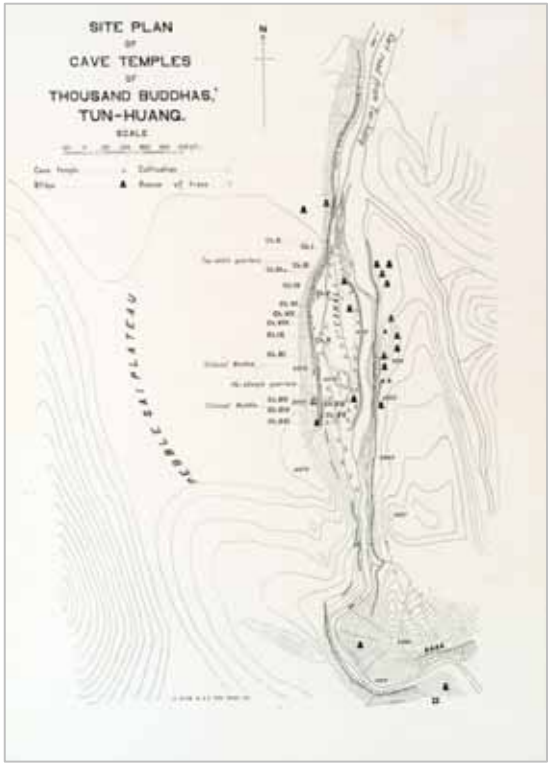


- **Problem 1**: Many existing IDs are not integrated.
- **Problem 2**: Cave information is not linked with other references.
- **Solution**: Digital survey for the database of caves.

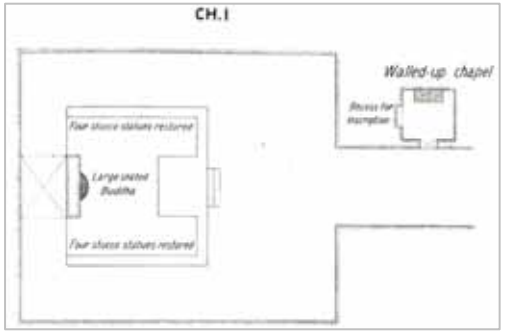
Digital Materials



Site plan by Pelliot



Site plan by Stein



Plan of cave

Cave photo

Antiquities founds in the Library Cave (Cave 17)

Digital materials from NII-Toyo Bunko Digital Archive

Existing IDs

- Stein Number
- Pelliot Number
- Zhang Daqian (張大千) Number
- Shi Yan (史岩) Number
- Current Number (given by Dunhuang Academy)
- **DSR ID** (given by us)

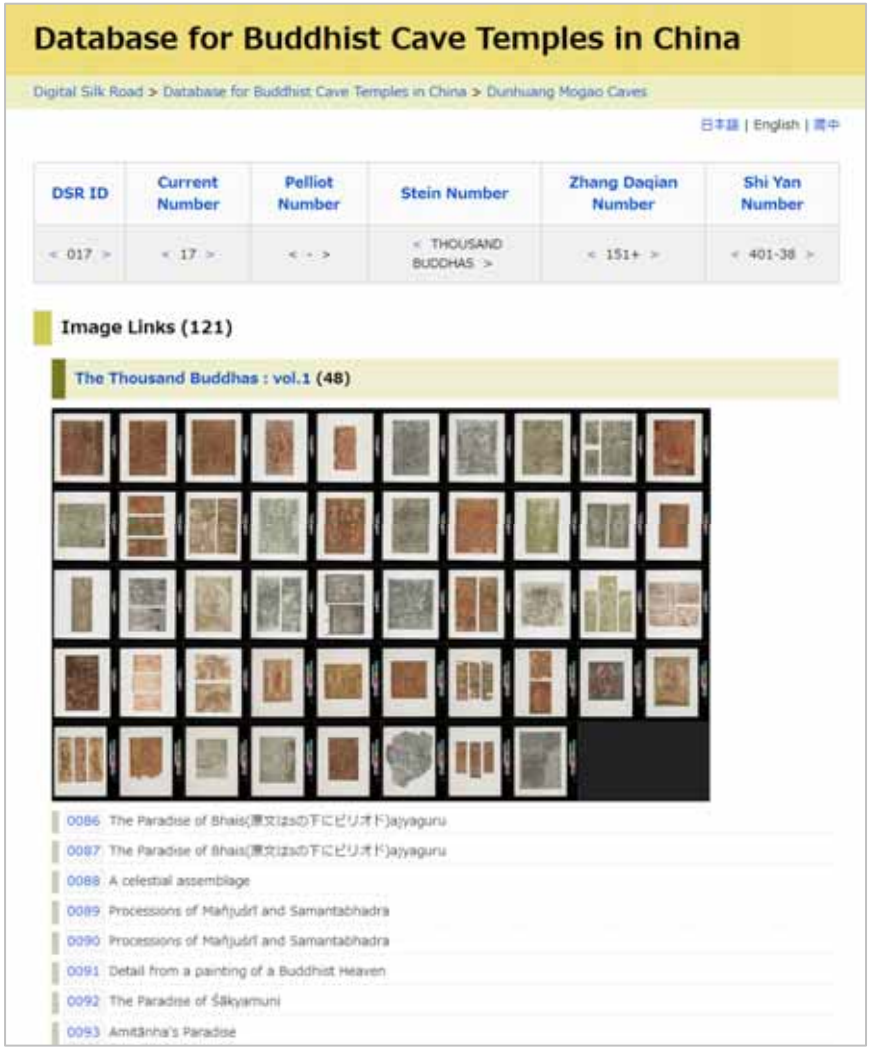
One cave has many IDs

Unique ID for integration

Linking IDs

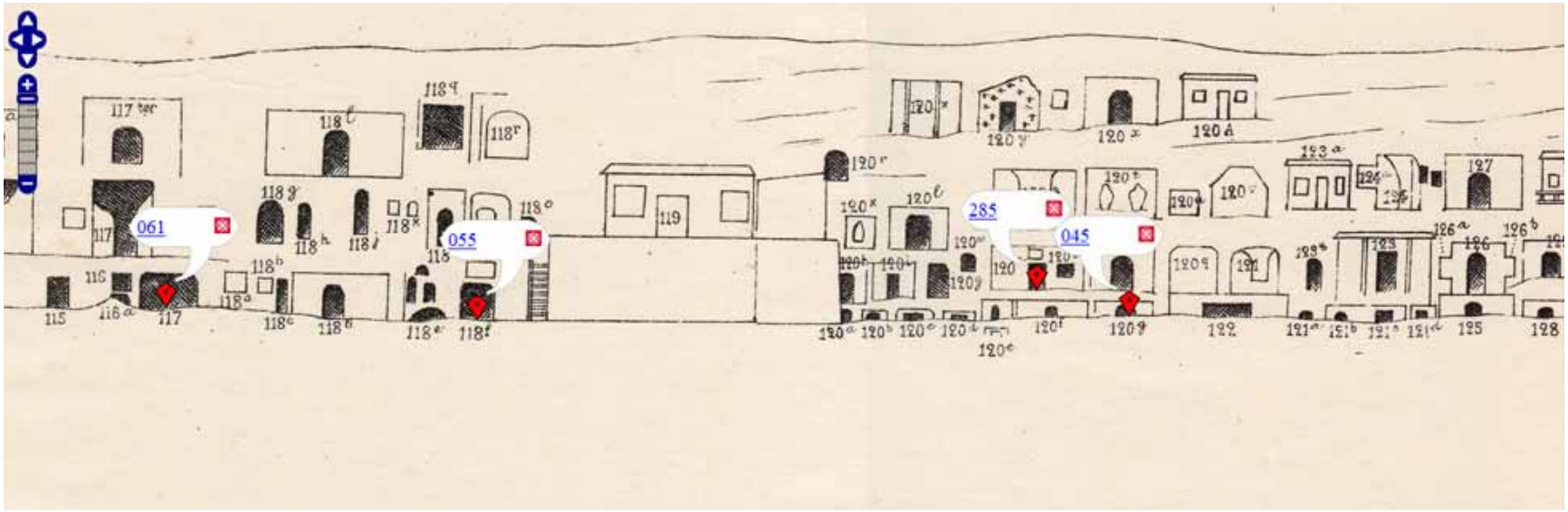
Current Number	Pelliot Number	Stein Number	Zhang	Shi
320	**139**	**CH. IV**	**125**	**281**
321	**139a**		**126**	**323**
322	**139b**		**127**	**324**
323	**140**		**128**	**325**
324			**128+**	**325-31**
325			**128+**	**325-32**
326	**141**		**129**	**326**
327	**142**		**130**	**327**
328	**143**	**CH. IX**	**131**	**328**

Information on Each Cave



- Comparison of multiple IDs with a navigation bar.
- Links to and thumbnail images from digitized books.
- Captions from digitized books.
- Commentaries from digital reference.

Search from Maps



- Openlayers for manipulating the map, zooming in/out, panning, placemarks.
- Spatial relationship between caves.

Digital Survey and Corrections

- **Cave IDs**: Identified Stein IDs from photographs and maps.
- **Book captions**: Correct book captions from photographs and maps.
- **Locations**: Correct cave locations from maps and plans.

Digitization involves comprehensive digital survey for higher reliability

Multiple IDs for a Single Cave

- Caption shows "CAVE **CH.III. A**"
- Cave 334

M. A. Stein, *Serindia*, vol. 2, fig. 209, Oxford: Clarendon Press, 1921.

- Caption shows "CAVE **CH. VI**"
- Cave 334 → CH. III.

M. A. Stein, *Serindia*, vol. 2, fig. 212, Oxford: Clarendon Press, 1921.

Multiple Caves for a Single ID

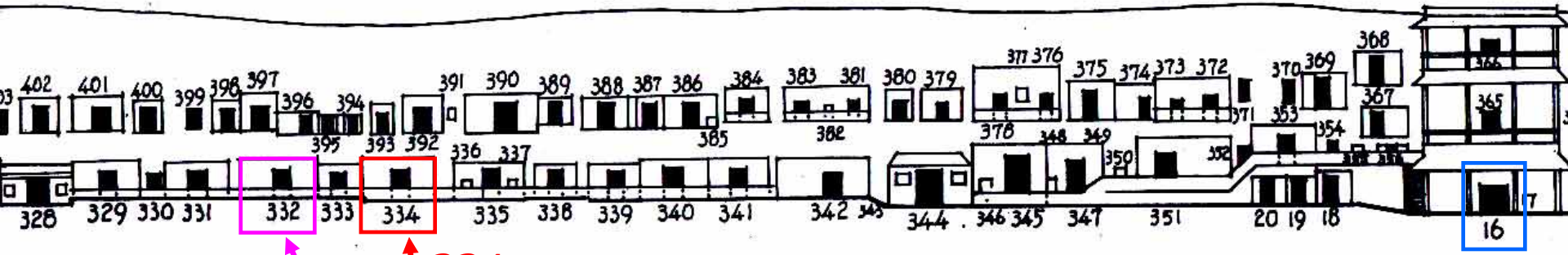
- Caption shows "CAVE **CH.III. A**"
- Cave 334

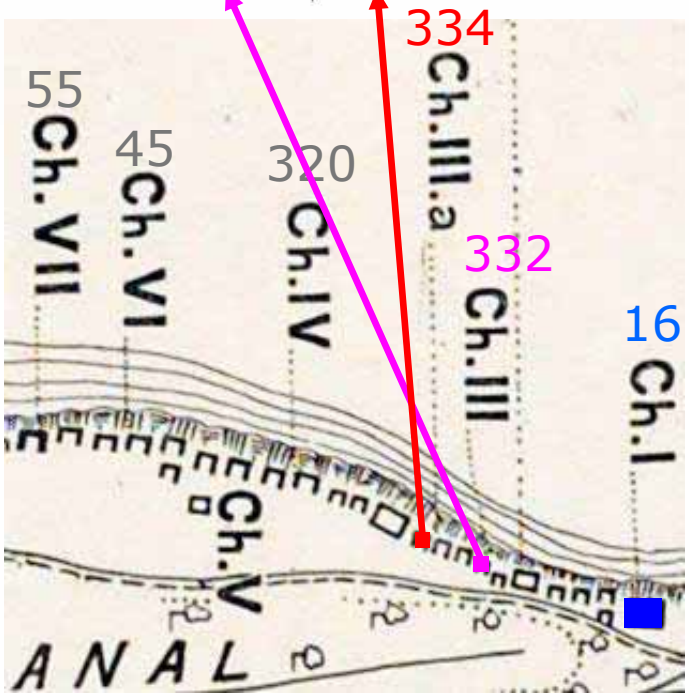
M. A. Stein, *Serindia*, vol. 2, fig. 209, Oxford: Clarendon Press, 1921.

- Caption shows "CAVE **CH.III. A**"
- Cave 45 → CH. VI

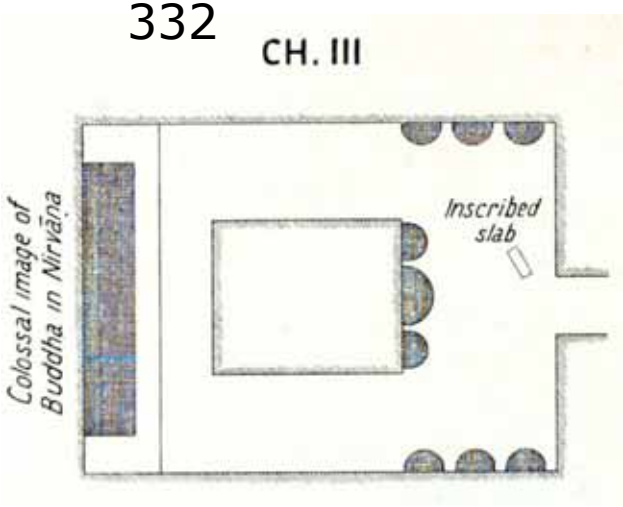
M. A. Stein, *Serindia*, vol. 2, fig. 208, Oxford: Clarendon Press, 1921.

Mismatched Relative Locations





CH. III = Cave 332



Commentary on Pelliot Catalogue for Dunhuang

Paper-based reference on Pelliot Catalogue

Format conversion

Integration of cave database and NII-Toyo Bunko Archive

Digital reference

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Digital Reference

洞窟编号（现行编号）	伯希和图录的卷数和图片编号						
第3窟	6-341	6-342	6-343				
第5窟	6-334						
第6窟	6-329	6-330	6-331	6-332	6-333		
第7窟	6-339						
第9窟	6-335	6-336	6-338	6-339	6-340	6-359	6-360
第12窟	6-339						
第16窟	6-354	6-363					
第17窟	6-368						
第25窟	5-297	5-298	5-299				
第27窟	5-286						
第31窟	5-287	5-288	5-289	5-290	5-291	5-292	6-357

《伯希和敦煌图录》图版说明 第6卷 图

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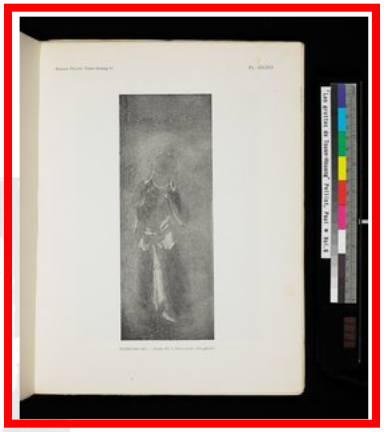
张景峰（敦煌研究院考古研究所助理馆员）

前壁左侧：敦编第3窟，元代开凿。此画面为东壁门南提净瓶观音像。观音身穿绿色络腋，紫色云肩，凌空而降，右手上举抚胸，左手下垂倒握净瓶，作向下倾倒状，脚踩莲花，局部画面已经模糊。此画面表现的是观音菩萨以甘露布施恶鬼的情景。



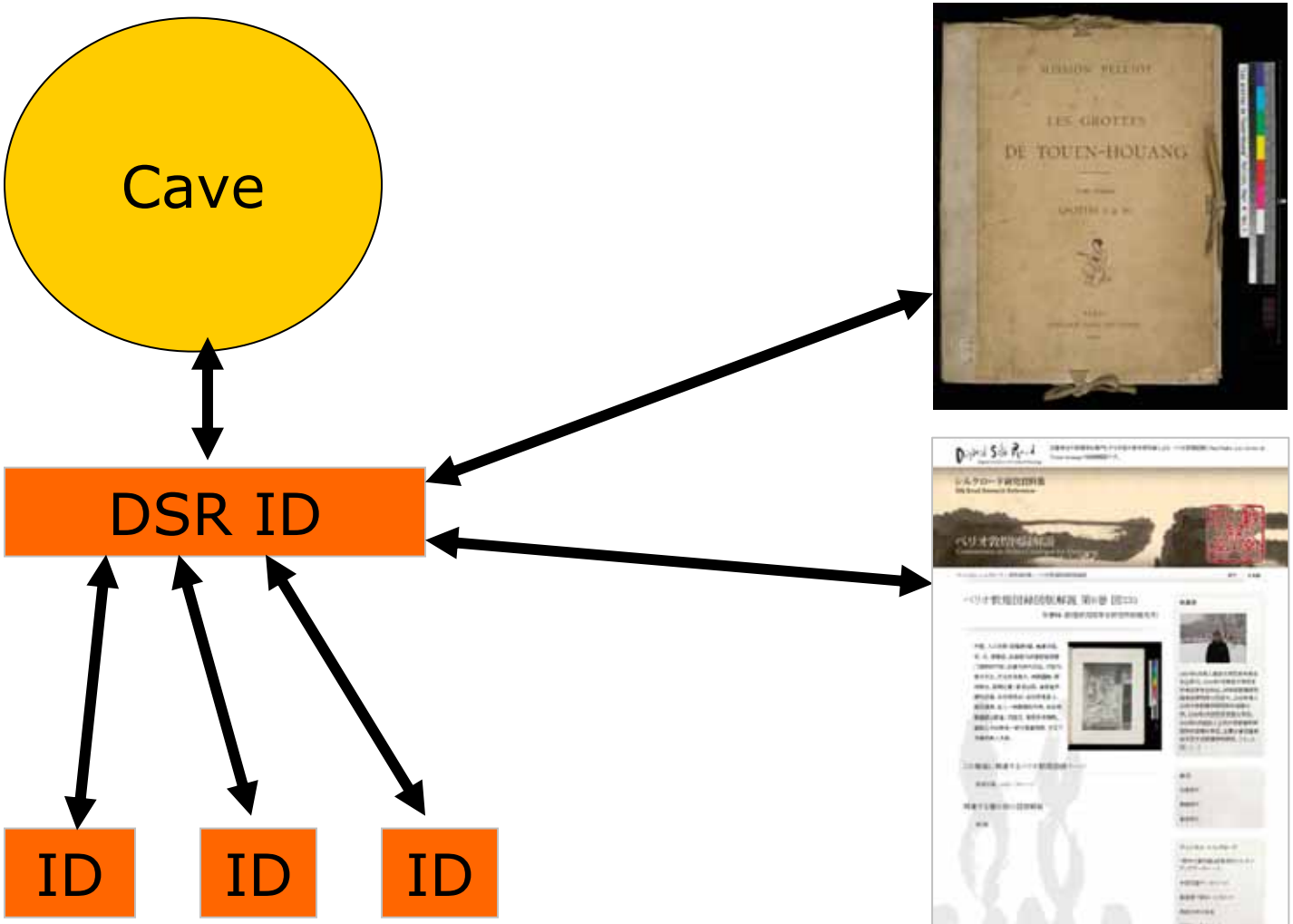
相关的《伯希和敦煌图录》网页

Toyo Bunko Digital Archive

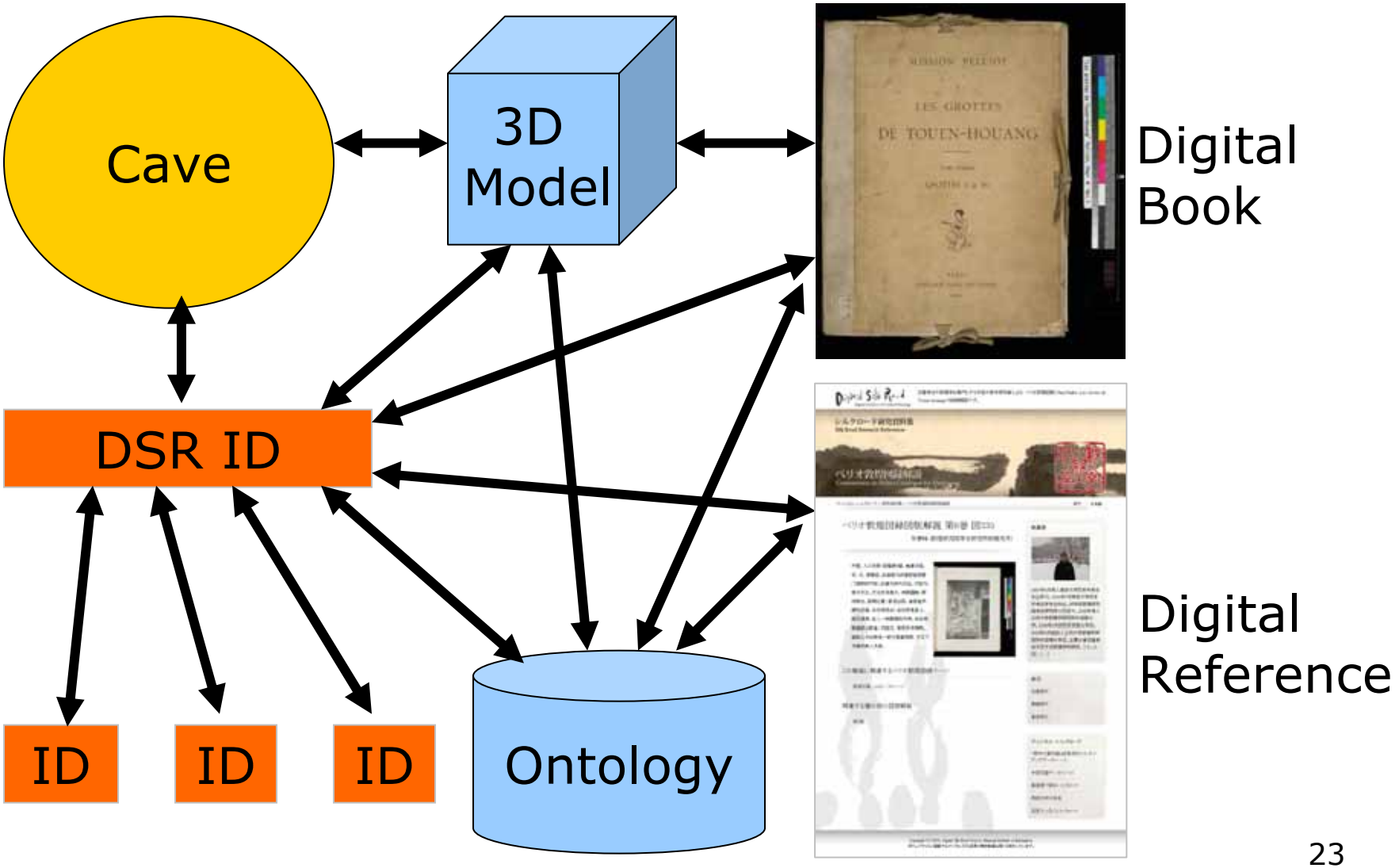
The Cave-Temples of Tun-Huang : vol.6 / Page 49

- Original books and references are packaged into one Web page.

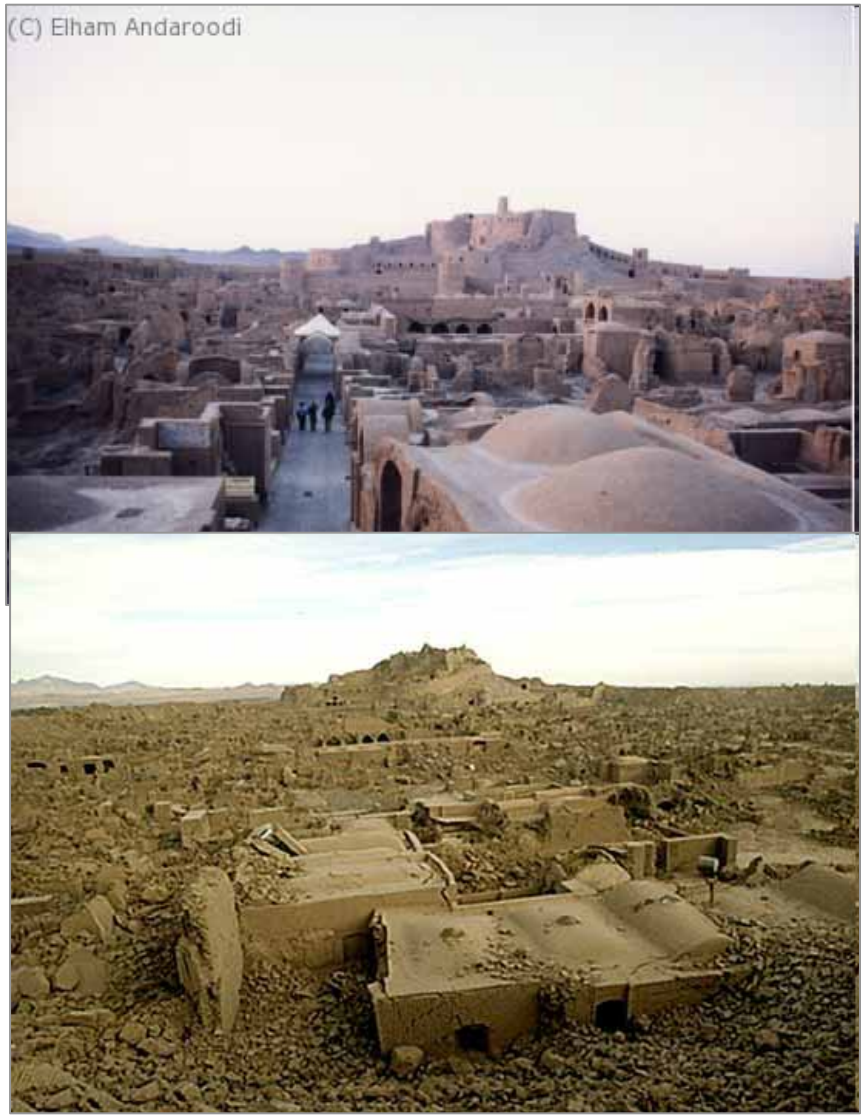
Current Status



An Idea for the Future



Case Study: Bam Project

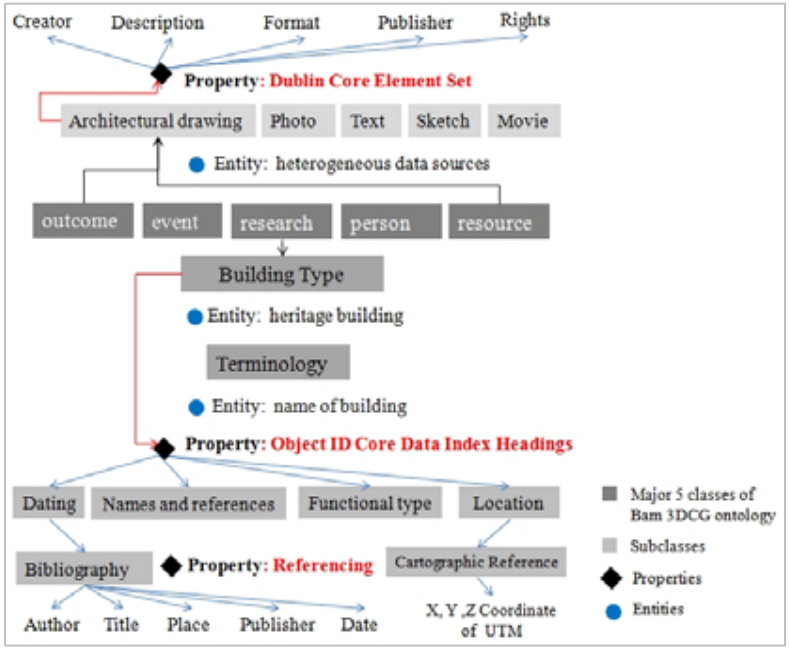


- Revive the Citadel of Bam, Iran - almost collapsed by the earthquake in Dec. 2003.
- 3D model and ontology was built for Bam data.

http://dsr.nii.ac.jp/bam/

http://dsr.nii.ac.jp/Bam3DCG/

Bam Ontology



- Ontology represents our knowledge about Bam cultural heritage.
- RDF (Resource Description Framework) is the description language.

Bam 3D Model

- Software: 3ds max + AutoCAD.
- High quality for professional use.

Measurement-Based 3D Modeling

New data cannot be captured from now!

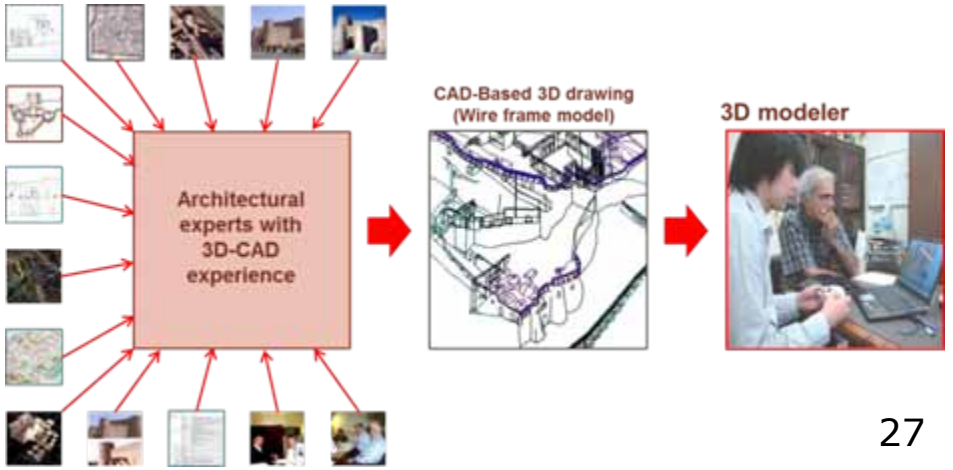
Laser scanning

Image: Wikipedia

Structure from Motion

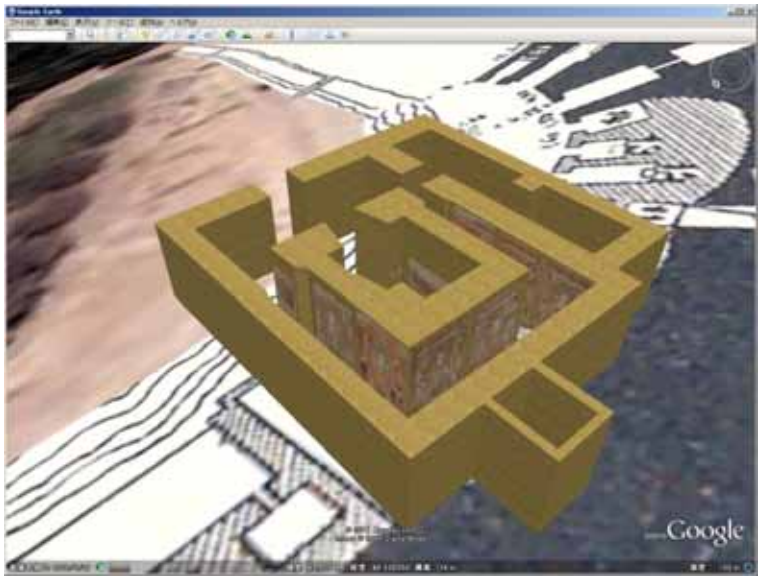
Image: Building Rome in a Day

Manual reconstruction from the integration of fragmented data and expert's knowledge.



Visually-Acceptable 3D Modeling

Google Earth



Second Life

- See the "inside" of Bezeklik Caves with paintings on the wall.

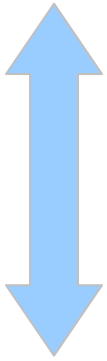
http://dsr.nii.ac.jp/3D/

Learning from Bam Project

- **Structure**: Accurate 3D models are required by professionals (geometry, color, discovery of hidden structures).
- **Semantics**: Ontology is useful for organizing our knowledge about caves (metadata, descriptions).
- **Preservation**: Documentation is precious for reconstruction after deterioration and disasters.

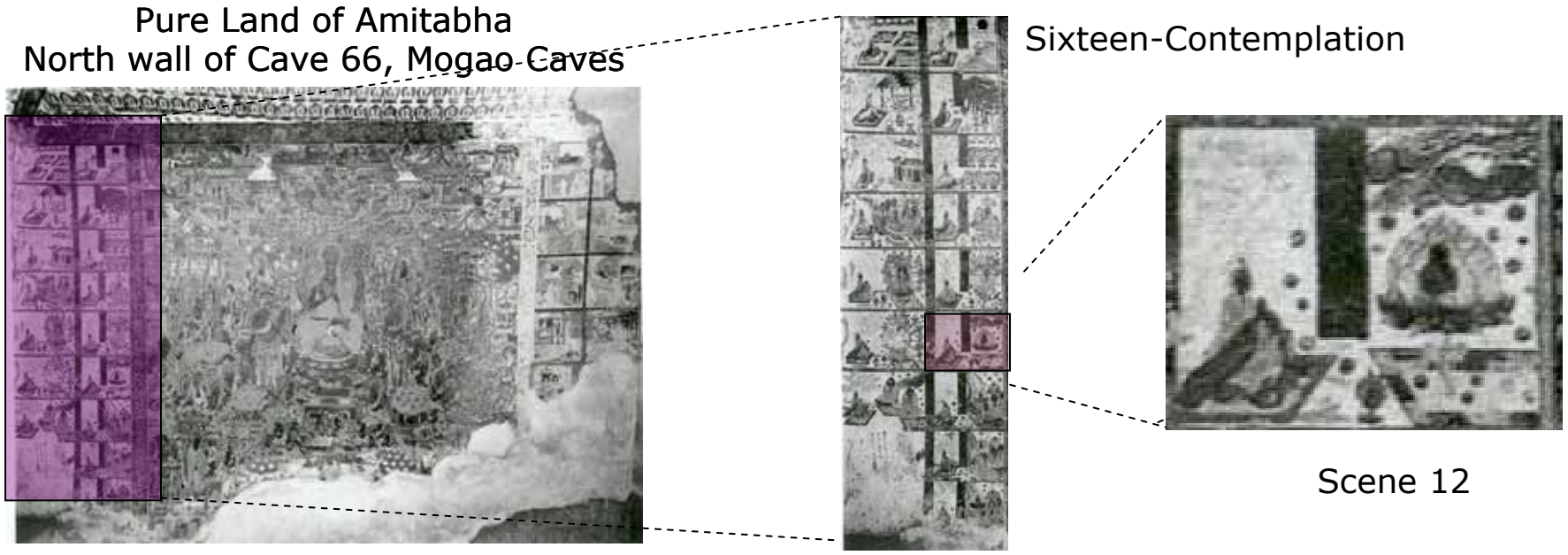
3D Models for Dunhuang

- **Geometry**: Laser scanning for measurement-based 3D models.
- **Texture**: Digital photographs for paintings and characters on the wall.
- **Color**: Multispectral sensors for accurate color measurement.



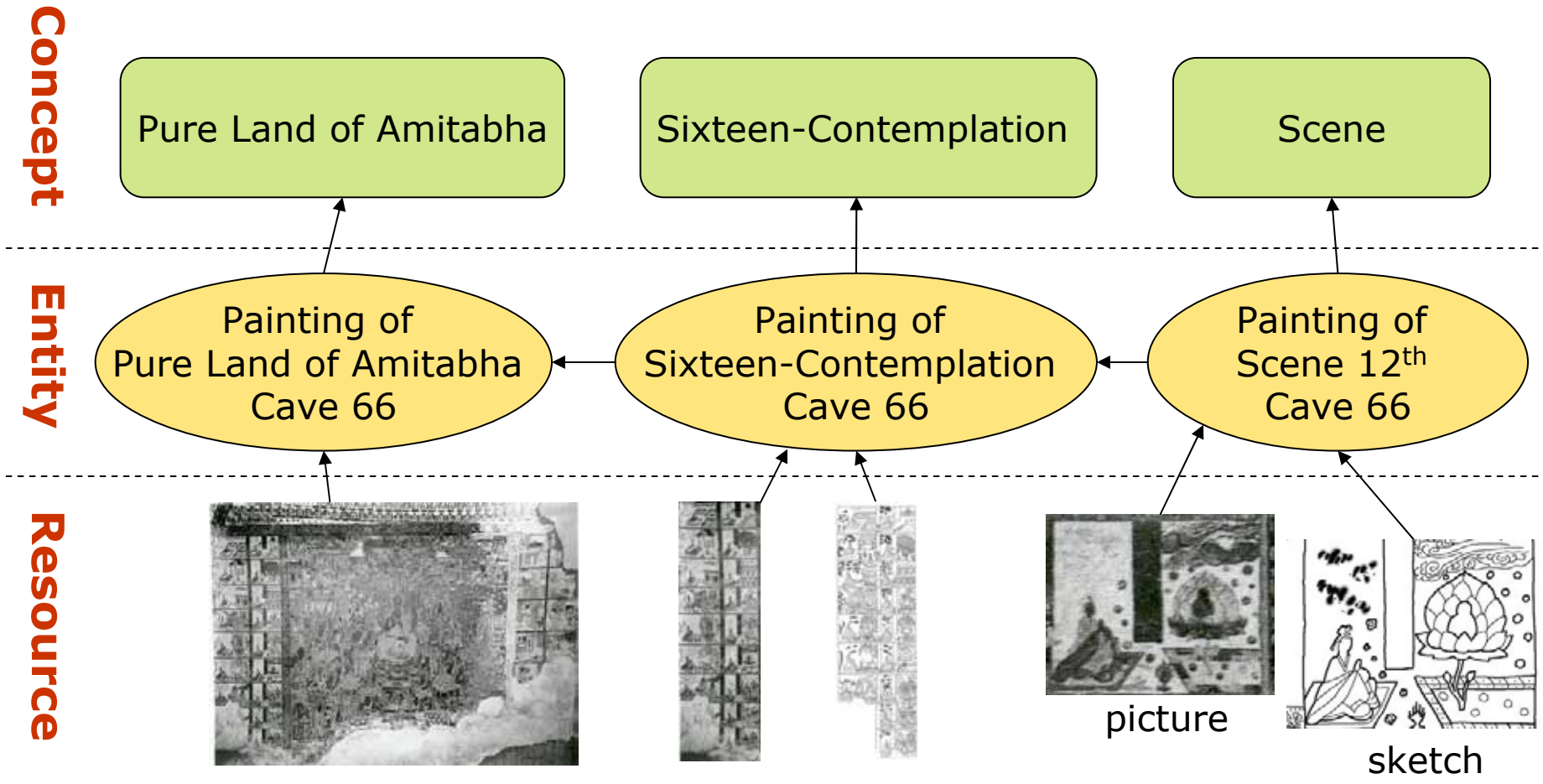
- **Measurement-based models**: valuable for research and preservation.
- **Visually-acceptable models**: useful for education and entertainment.

3D Semantic Database



- Digitization of each wall (north, ceiling, ...) leads to the 3D database of caves.
- Ontology-based 3D semantic database can deal with the complex structure of caves.

Semantic Modeling



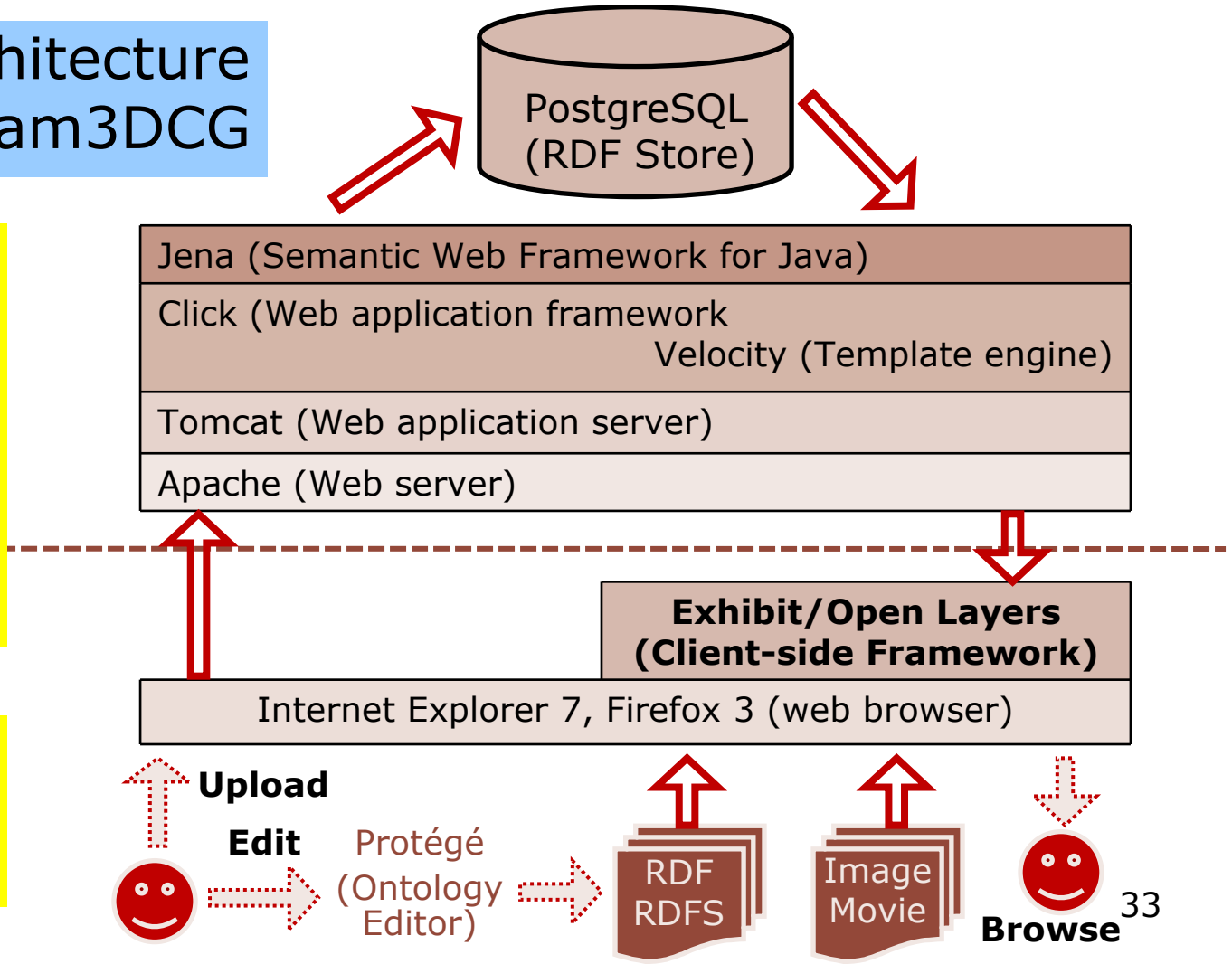
- Paintings of sixteen-contemplation

Ontology-based Semantic Database

System architecture for Bam3DCG

Open source software (OSS) is now mature enough for large-scale systems.

Integration of systems is still a big task.



How to Make?

- **3D Model**: Laser scanning + computer graphics
  - Technically mature, but costly..
- **Ontology**: Open source software + software development
  - Reliable enough, but lack of experts..
- **Data Policy**: Share or hide?
  - Worldwide platform or internal system?

Summary

- "Digital Silk Road" project was introduced from the viewpoint of Dunhuang Mogao Caves.
- An idea toward "Digital Dunhuang" was discussed in terms of database, 3D modeling and ontology.
- "Digital Dunhuang" is technically feasible, but lacks resources.
- Who will take the next step?

Websites

- Digital Silk Road
  - http://dsr.nii.ac.jp/
- NII-Toyo Bunko Digital Archive of Rare Books
  - http://dsr.nii.ac.jp/toyobunko/
- Database for Buddhist Cave Temples in China
  - http://dsr.nii.ac.jp/china-caves/
- Commentary on Pelliot Catalogue for Dunhuang
  - http://dsr.nii.ac.jp/reference/pelliot/

Collaborators

- Bam Project: Elham Andaroodi, Mohammad-Reza Matini, University of Tehran, ICHTO, Waseda University, ENSAPVS, EVCAU
- NII-Toyo Bunko Digital Archive: Yoshinori Shiba, Issei Tanaka (Toyo Bunko)
- Database of Buddhist Cave Temples: Takako Toyoma, Michiyo Mori
- Commentary on Pelliot: Sha Wutian, Dang Yanni, Zhang Jingfeng, Zhang Shanqing (Dunhuang Academy, Institute of Dunhuang Studies / Lanzhou University)
- Software Development: Tomohiro Ikezaki

Many thanks for the collaboration!