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Exchanging Observations and Measurements: a Generic Model and Encoding

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INTRODUCTION

Much of the information concerning the natural world that is transferred or otherwise shared is based on Observations and Sampling. These provide the **evidence** that forms the basis for the description of features, interpretations and models. In many cases, the detail of how the observations were actually made is of little interest, and it is sufficient to embed the results in the description of a feature instance. However, in other cases, more information is needed. It turns out that the kinds of information that are associated with the report of an act of observation are common, across all disciplines, when classified appropriately. Consider the following statements:

- The 7th banana weighed 270gm on the kitchen scales this morning
- The attitude of the foliation at outcrop 321 of the Leederville Formation was 63/085, measured using a Brunton on 2006-08-08
- Specimen H69 was determined on 1999-01-14 by Amy Bachrach to be of the species Eucalyptus Caesia
- IR image ASgh67c of Camp Iota was obtained by Aster in 2003
- Sample WMC997t collected at Empire Dam on 1996-03-30 was found to have 5.6 g/T Au as measured by ICPMS at ABC Labs on 1996-05-31
- The X-Z Geobarometer determined that the ore-body was at depth 3.5 km at 1.75 Ga
- The simulation run on 2004-09-09 indicated a pressure reduction of 4 MPa in geologic unit Q at 600 Ma.

All of these sentences contain the same kinds of information, though not in the same order. Recognizing this, we may encode the descriptions of observations and their results in a common way. This will allow observational data to be shared across discipline boundaries, satisfying a common requirement in applications concerning natural resources and the environment. It will also encourage the development of standard interfaces for observational data, and common processing and visualization systems.

Figure 1 represents the information provided in the sentences above using the formal notation of Unified Modeling Language (UML) Object Diagrams. (UML is an OMG and ISO standard. There are many introductory books and websites for the uninitiated.) The key point is that all Observations can be described in terms of the same set of properties: a feature-of-interest, observed-property, sampling-time, procedure, and result. The information may be described by a common model or schema.

In some cases some additional details are provided. For example, two of the examples include a result-time (i.e. the time that the procedure was completed) that is different than the sampling time (the time of interaction with the real-world). The descriptions of the objects related to the Observation may also be elaborated. For example, the feature-of-interest may have an associated sampled-feature, and the location of the procedure (laboratory) may be provided. The latter pattern is supported by the object-oriented analysis, which focuses on encapsulation of the information in suitable classes.

INFORMATION MODEL

Based on the analysis above, we have developed a standard model for Observations, and an associated model for the description of Sampling Features, such as specimens, sections, traverses, outcrops, boreholes, etc, as shown in Figures 2-5. The details of these models are provided in two Open Geospatial Consortium standards (Cox, 2007a, b).

Perhaps the key aspect of the observation model, which lends it the flexibility to be useful across such a wide array of applications, is the notion of the feature-of-interest. This general pattern was first introduced by Fowler and Odell, based on work in the medical sector (Fowler, 1998). The feature-of-interest externalizes the description of the details of the observation target, separating this from the description of the observation procedure, thus allowing both remote and in-situ observations to be described using the same structure.

The addition of the Sampling Feature concept allows a sampling artifact to be interposed, which also supports the description of ex-situ observations – i.e. where a specimen is removed from the ultimate feature of interest, and analyzed in a laboratory remote from the real-world location. For some more elaborate applications of the Sampling Features model, in particular showing the usefulness of the “related sampling feature” association, see https://www.seegrid.csiro.au/twiki/bin/view/AppSchemas/ObservationsAndSampling .

The Observations and Sampling models are imported and used in the GeoSciML information model that has been developed by the Interoperability Working Group of the IUGS Commission for Geoscience Information (Simons et al. 2006, Laxton & Wyborn, 2007) and is to be used in the OneGeology project (Jackson & Wyborn, 2007).

These standards (Cox, 2007a, b) also provide an XML encoding that may be used for transfer of observational data. The encoding is provided as a GML-conformant (Cox et al. 2001; Cox et al. 2003; Portele 2007) XML Schema, which makes it compatible with the OGC-WFS service interface (Vretanos 2004). The OGC Sensor Observation Service interface is specifically designed to provide access to collections of observations (Priest and Na 2007).

ACKNOWLEDGEMENTS

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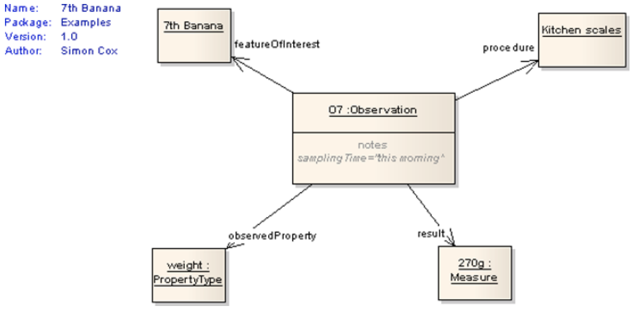
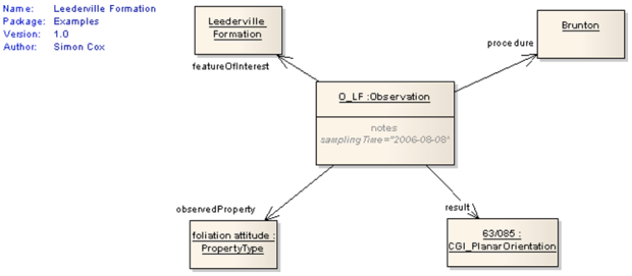
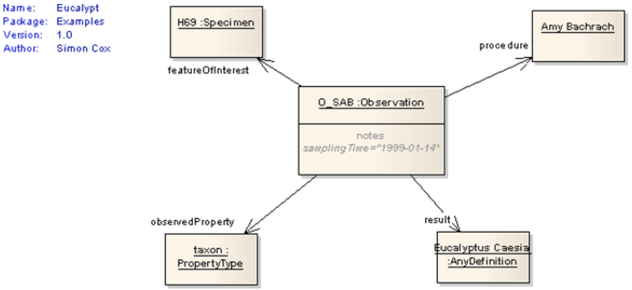
Vretanos, P., 2004, Web Feature Service (WFS), version 1.1 OpenGIS® Implementation Standard, OGC document 04-094, accessed at http://portal.opengeospatial.org/files/?artifact_id=8339.



A.



B.



C.

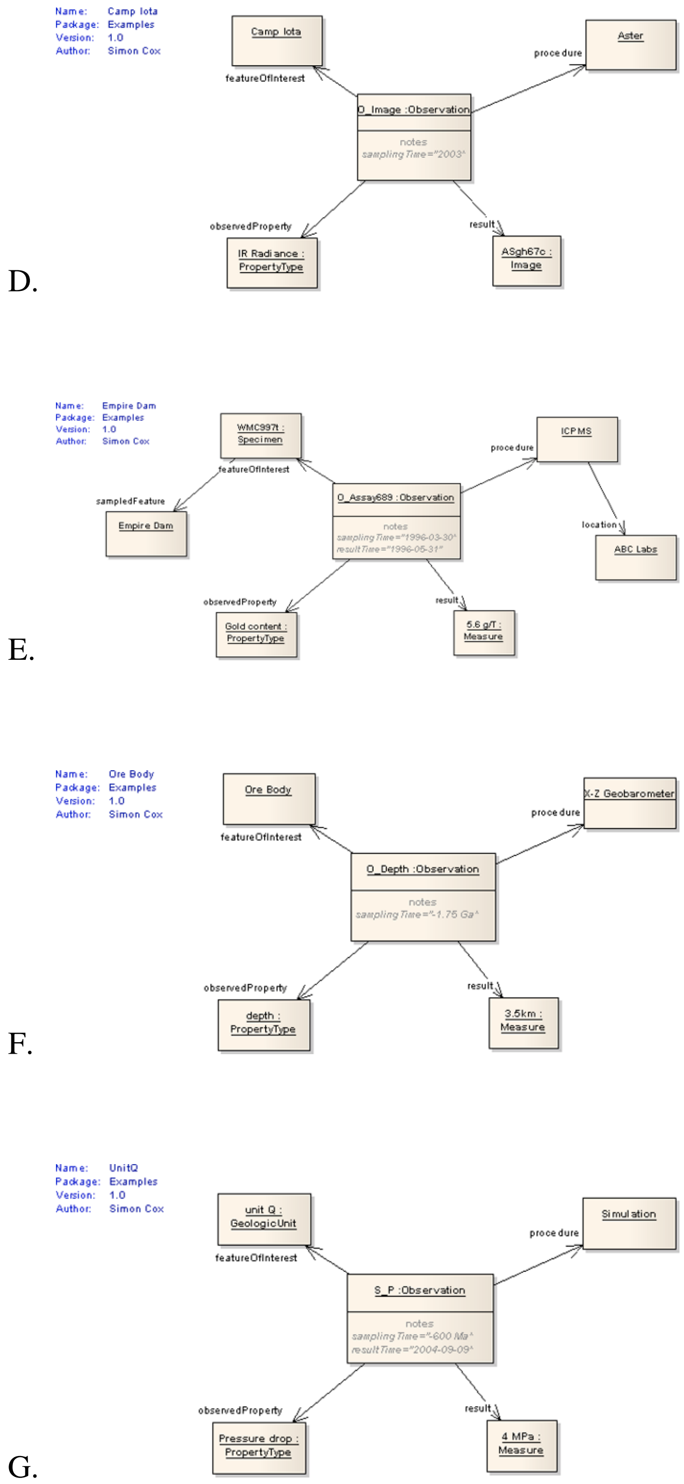


Figure 1. A-G. UML Object Diagrams for the observation examples.

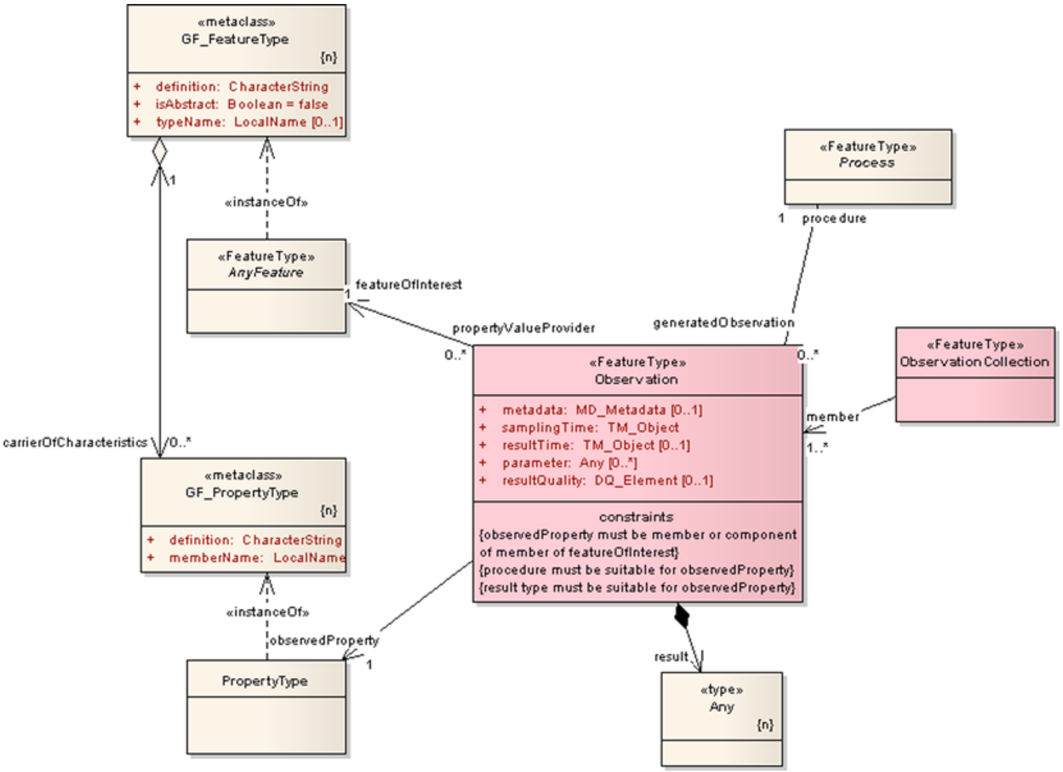


Figure 2. UML Static Class Diagram for the Observation Model (from Cox, 2007a).

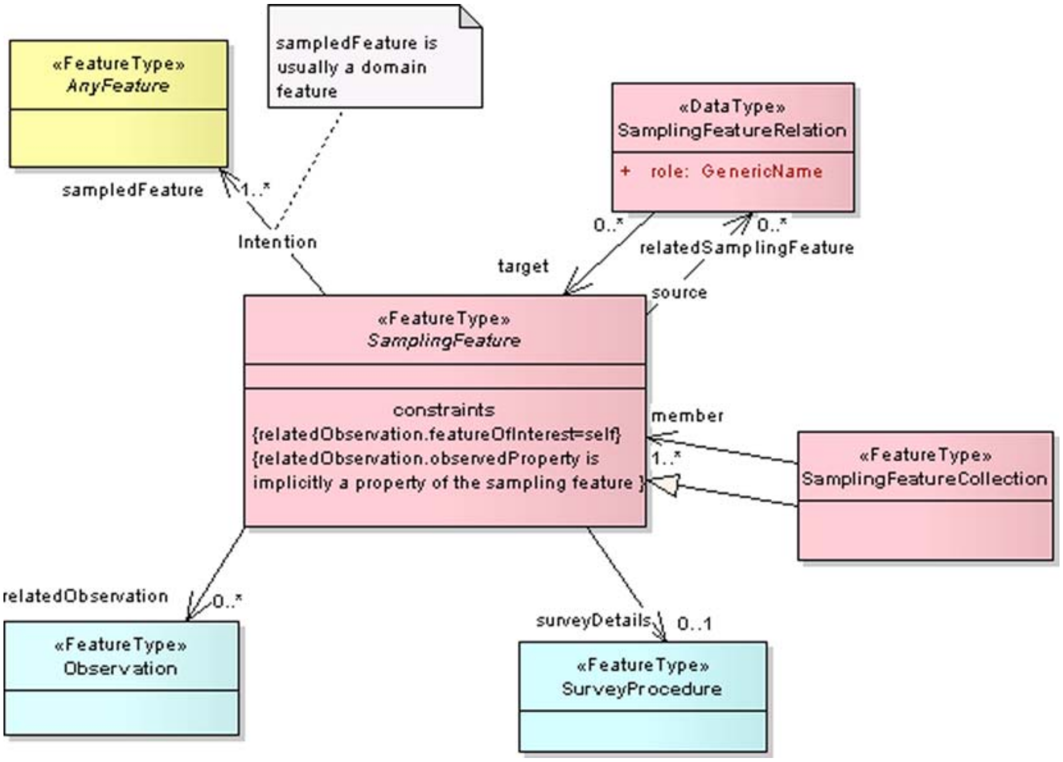


Figure 3. UML Static Class Diagram for the base Sampling Feature model (from Cox, 2007b).

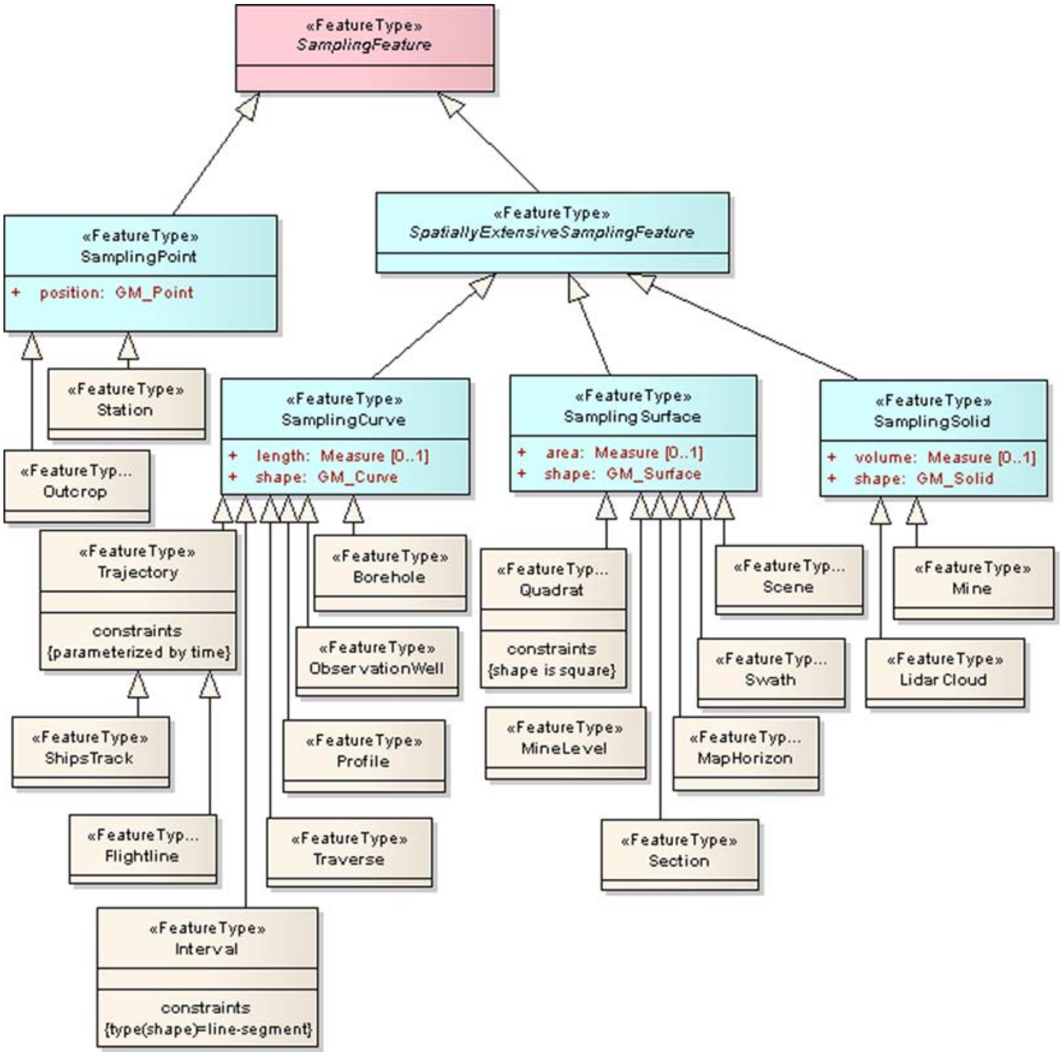


Figure 4. UML Static Class Diagram for Sampling Manifolds, showing various domain-related specializations (from Cox 2007b).

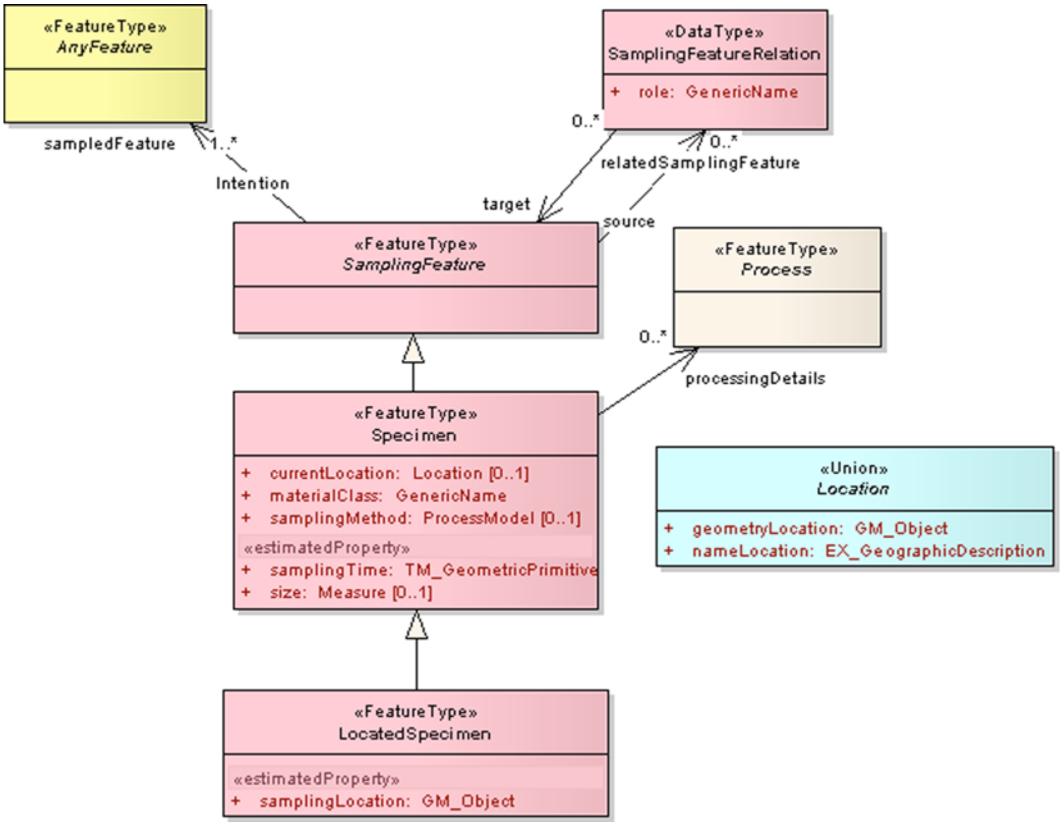


Figure 5. UML Static Class Diagram for Specimens (from Cox 2007b).