
DELIVERABLE

D7.5 Validation of pre-operational access phase to selected site and station characterization datasets

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Summary

This report presents a pragmatic and flexible strategy to disseminate site characterization information between network operators and European services (European Geotechnical Database, EGD; ORFEUS StationBook, ESM) based on the already existing standard FDSN Web Service Station response (StationXML). We first describe site characterization metadata file (SiteXML) and related schema that includes both required site characterization information by EGD and site characterization most advocated indicators resulting from the international questionnaires and workshop conducted in SERA Task7.2. We then propose to use the already existing standard FDSN Web Service Station response (StationXML) to disseminate the site characterization information: the URL of SiteXML is introduced in the <ExternalReference> element in the StationXML structure, that allows site characterization metadata to be retrieved in real-time and then exposed in, e.g. EGD, ORFEUS-StationBook or ESM service. A sample XML file has been exposed by RESIF. Retrieval of the site characterization information from SiteXML is under current testing by ORFEUS and EGD before going to production phase for the RESIF stations (33 stations; Hollender et al., 2018) and large dissemination of the procedure among network operators.

Introduction

The aim of Task 7.5 (Pre-operational service activities) in SERA is to offer a pre-operational access service to selected subset of station characterization based on the results of Task 7.2 (Best practice and site characterization quality assessment). Thanks to international questionnaires and an international workshop, Task 7.2 has defined a list of 7 indicators considered as mandatory for a reliable site characterization and has proposed a quality metrics strategy aiming at evaluating in a quantitative way the overall quality for a site characterization analysis. Meanwhile, evaluation of available site characterization at permanent strong motion stations in Europe within Task 7.3 has clearly outlined that a large proportion of site characterization information is currently available only upon request to specific scientists or through scientific papers, which critically hampers promoting scientific research and engineering use of European seismological data. The European Geotechnical Database (EGD, <http://egd-epos.civil.auth.gr/>), in development within EPOS, ESM (<https://esm.mi.ingv.it>) or ORFEUS station book (<https://www.orfeus-eu.org/opencms/stationbook/>) are definitely European services that could gather in a systematic way and with harmonized format, the site characterization information available at European seismological networks.

Given the very small number of strong motion networks that expose the site characterization information on-line (<http://stations.seismo.ethz.ch/> in Switzerland; <http://itaca.mi.ingv.it> in Italy; <http://kyhdata.deprem.gov.tr> in Turkey), and most generally, the absence of running site characterization databases and common structuration of site characterization metadata at network operator level, we propose a pragmatic strategy to disseminate site characterization metadata based on existing standard FDSN Web Service-Station response. The strategy is as follows:

- Site characterization metadata is described by a .XML file (siteXML), whose technical details are provided in the next section ;
- siteXML is introduced in the <ExternalReference> element in the StationXML structure. This element contains the URL to the site.XML hosted by the network operator of an authoritative data center (Figure 1). A timestamp is added as a free text at the end of the <Description> element of <ExternalReference> in order to ensure tracability of any update of the siteXML file (Figure 1) ;
- The station owner is responsible to maintain and update the SiteXML file, according to the update in the scientific knowledge of site characterization for the given seismic station ;

Through the FDSN Web Service-Station response, the SiteXML file can be retrieved in real-time and site characterization content can be retrieved in order to expose information in, e.g. EGD, ORFEUS-StationBook or ESM service. This approach was agreed by the Orfeus strong motion committee meeting that was held on October 10, 2019 in Grenoble.

StationXML for the OGPC RESIF station has been modified such as to include the SiteXML in the <ExternalReference> element, with a GIT repository for the SiteXML at RESIF stations accessible at the following address: <https://gitlab.com/resif/site-characterization>. Retrieval of the site characterization information from SiteXML is under current testing by ORFEUS and EGD before going to production phase for the RESIF stations (33 stations; Hollender et al., 2018) and large dissemination of the procedure among network operators.

In the following sections, we provide a general description of the SiteXML schema, definition of new introduced parameters required by SERA and a XML sample file for OGPC strong motion station.

```
<Station code="OGPC" startDate="1998-08-25T10:00:00" endDate="2500-12-31T23:59:59" restrictedStatus="open" resif:alternateNetworkCodes="RA">
  <Latitude>45.137100</Latitude>
  <Longitude>5.698750</Longitude>
  <Elevation>215.000000</Elevation>
  <Site>
    <Name>Bridage motorisée de Gendarmerie, 38317 Le Pont de Claix, Isère, Rhône-Alpes, France</Name>
  </Site>
  <Geology>Unknown</Geology>
  <Operator>
    <Agency>Observatoire des Sciences de l'Univers de Grenoble (OSUG)</Agency>
  </Operator>
  <CreationDate>1998-08-25T10:00:00</CreationDate>
  <TotalNumberChannels>24</TotalNumberChannels>
  <SelectedNumberChannels>24</SelectedNumberChannels>
  <ExternalReference>
    <URI>https://gitlab.com/resif/site-characterization/-/raw/master/XML/SiteOGPC_SERA_v1.1.xml</URI>
    <Description>Site characterization for station OPGC, network RA, updated 2020-04-12 </Description>
  </ExternalReference>
  <Channel locationCode="00" code="HNE" startDate="1998-08-25T10:00:00" endDate="2001-03-29T09:49:00" restrictedStatus="open">
    <Latitude>45.1371</Latitude>
    <Longitude>5.69875</Longitude>
    <Elevation>215.0</Elevation>
    <Depth>0.0</Depth>
```

Figure 1. Example of Site.XML (SiteOPGC_SERA_v1.2.xml) introduced in the <ExternalReference> element in StationXML for the OGPC permanent strong motion station operated by RESIF (RA network).

Description of site.xml schema

The SiteXML follows closely the SiteCharacterization QuakeML2.0 schema (<https://quake.ethz.ch/quakeml/QuakeML2.0/SiteCharacterization>) and the additional fields specification introduced by EGD as described in SERA D7.1 Deliverable (Standard for site condition metadata). The SiteXML includes most of the EGD parameters and the 7 indicators (resonance frequency, V_{S30} , surface geology, EC8 site class, seismological bedrock depth, engineering bedrock depth, V_S profiles) and their related quality grading (Qindex1 for each indicator and the Final Quality index) as defined in SERA Task 7.2 (see Deliverable D7.2). QuakeML representation has thus to be extended to account for the SERA indicators.

SiteXML schema contains 3 elements (Figure 2):

- **SiteOwner** provides information (contact, address, institution, ...) about the owner of the site characterization information (Figure 3). This element has been introduced by EGD and details on

the content of this element can be found in SERA D7.1 (Standard for site condition metadata) Deliverable.

- **siteCharacterizationParameters** provides the following site characterization indicators: resonance frequency, V_{S30} , V_S profiles as well as indicate the presence at the site of SPT, CPT or borehole measurements.
- **siteDescription** provides information on EC8 ground type, engineering bedrock depth (H_{800}), seismological bedrock depth, surface geology, site morphology, site topology and location of site characterization measurements.

The full schema (QuakeML-SERA-1.2.xsd) is currently hosted at <https://gitlab.com/resif/site-characterization> while waiting for future decision by the site characterization community, ORFEUS and ESM regarding the official hosting location of the schema.

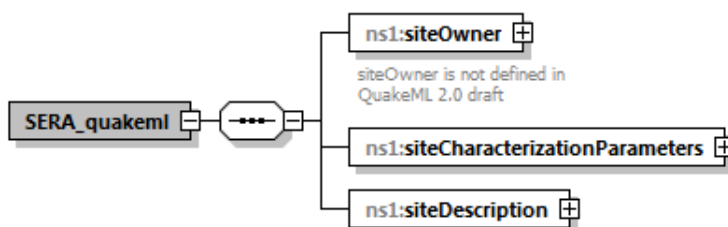


Figure 2. Main elements of the Site.XML

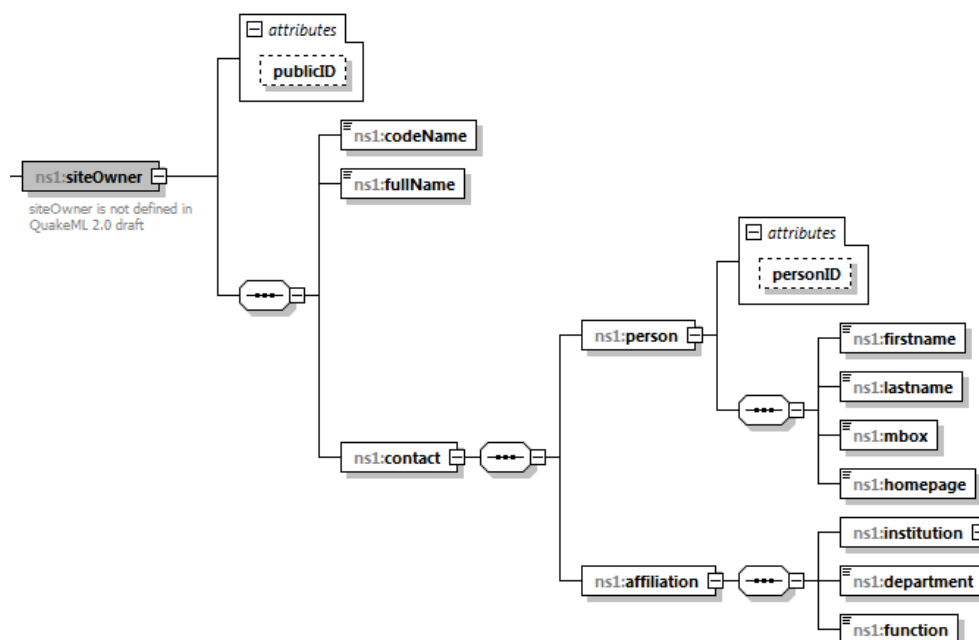


Figure 3. Schema of the <siteOwner> element

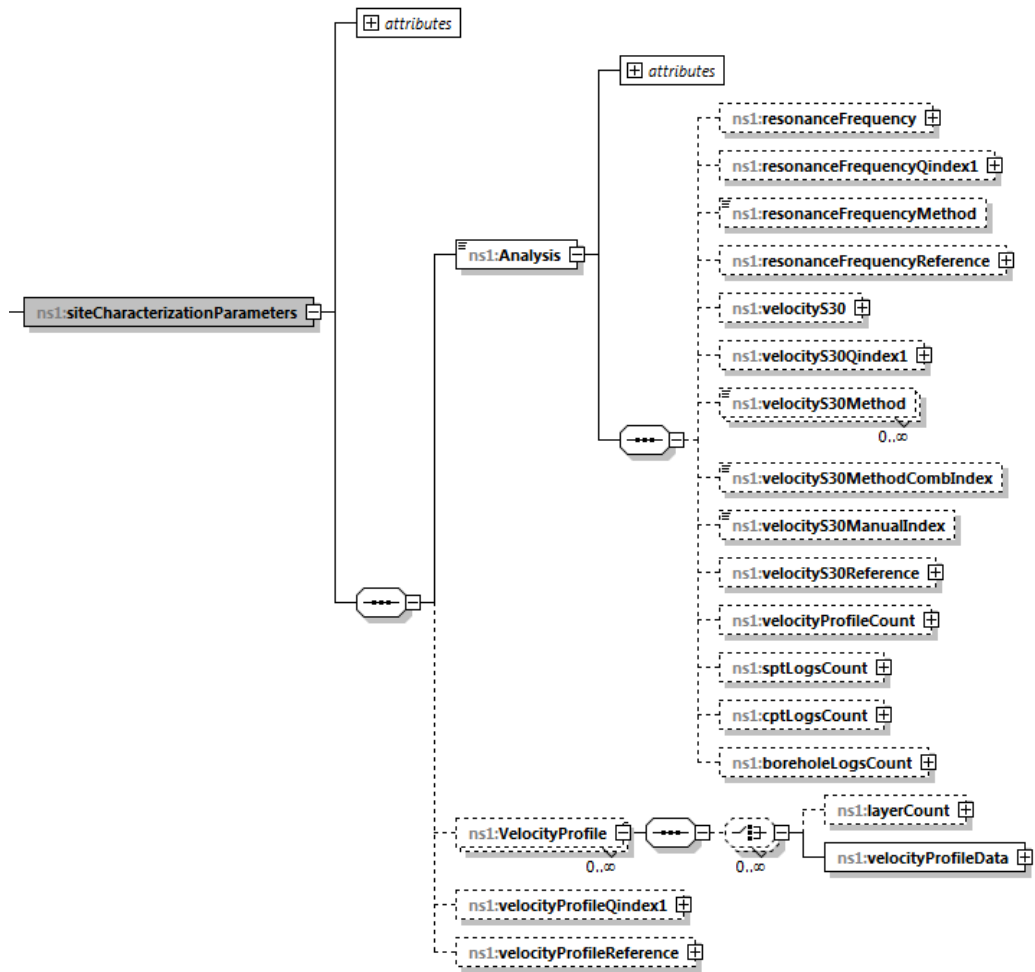


Figure 4. Schema of the <siteCharacterizationParameters> element

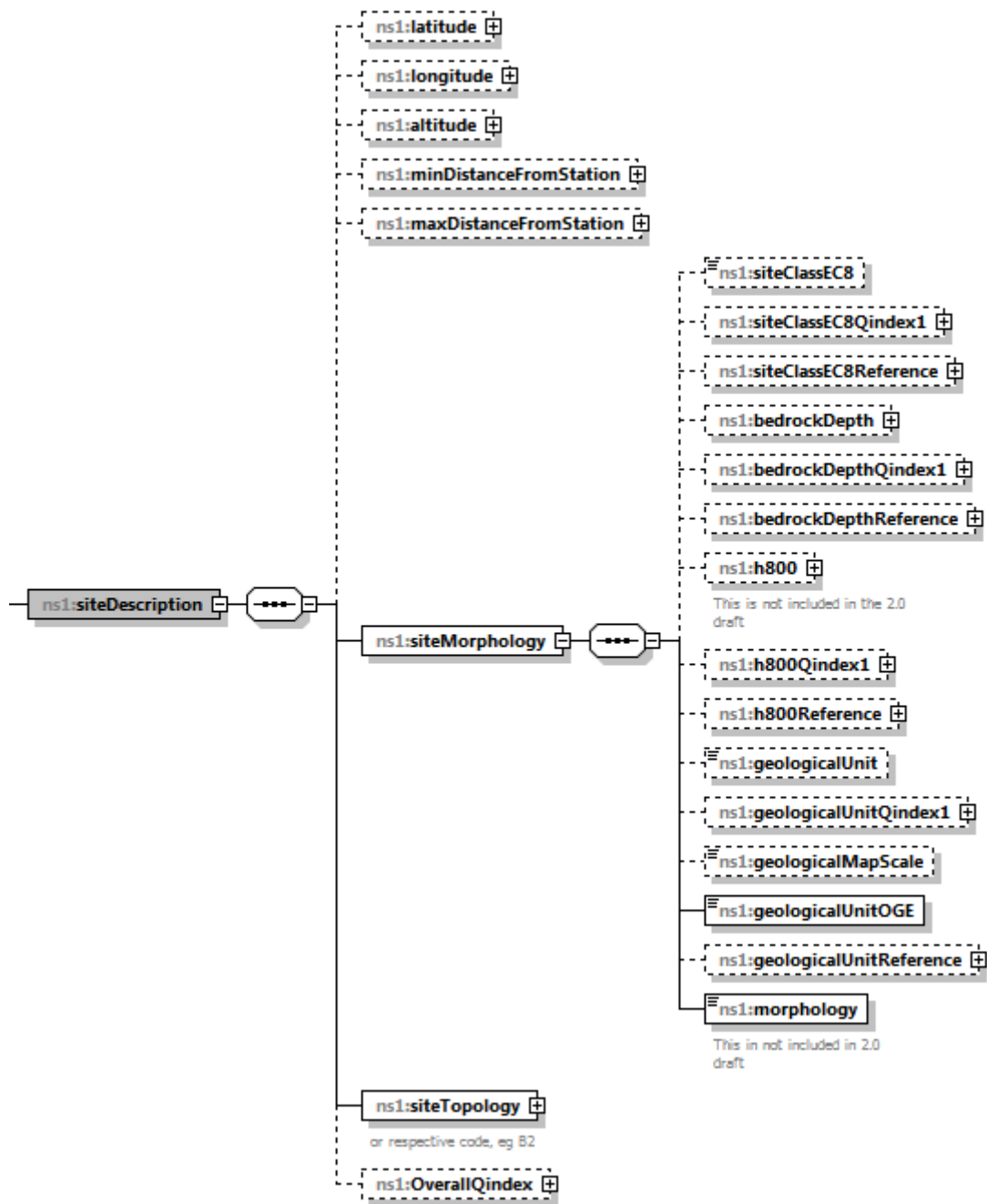


Figure 5. Schema of the <siteDescription> element

Definition of specific parameters required in Site.XML

Definition and description of various elements of the Site.XML file are available in the following URL: <https://quake.ethz.ch/quakeml/QuakeML2.0/> and in the SERA D7.1 Deliverable (Standard for site condition metadata). We provide in Table 1 definitions of the newly introduced fields required in SiteXML and fields not yet described in QuakeML2.0 draft.

Tableau 1. Description of new field elements required in SiteXML

Field	Description	Restrictions to values	Unit
resonanceFrequencyQindex1	Quality grading1 as defined in SERA D7.2	From 0 to 1	
velocityS30Qindex1	Quality index 1 as defined in SERA D7.2	From 0 to 1	
siteClassEC8Qindex1	Quality index 1 as defined in SERA D7.2	From 0 to 1	
bedrockDepthQindex1	Quality index 1 as defined in SERA D7.2	From 0 to 1	
h800Qindex1	Quality index 1 as defined in SERA D7.2	From 0 to 1	
geologicalUnitQindex1	Quality index 1 as defined in SERA D7.2	From 0 to 1	
velocityProfileQindex1	Quality index 1 as defined in SERA D7.2	From 0 to 1	
OverallQindex	Final Quality index as defined in SERA D7.2	From 0 to 1	
ResonanceFrequency.uncertainty	Uncertainty on site resonance frequency		Hz
velocityS30.uncertainty	Standard deviation of Vs30		m/s
bedrockDepth.uncertainty	Uncertainty of seismological bedrock depth		m
h800.uncertainty	Uncertainty of engineering bedrock depth		m
minDistanceFromStation	Minimum distance between the permanent seismological station and site characterization measurement. Should be used only when representative latitude and longitude of site characterization measurements cannot be provided		m
maxDistanceFromStation	Minimum distance between the permanent seismological station and site characterization measurement. Should be used only when representative latitude and longitude of site characterization measurements cannot be provided		m
Child elements of <velocityProfileData>			
Density.value	density		kg/m ³
Density.uncertainty	Uncertainty on density		kg/m ³
velocityP.value	Compressional (P) wave velocity		m/s
velocityP.uncertainty	Uncertainty of (P) wave velocity		m/s
velocityS.value	Shear (S) wave velocity		m/s
velocityS.uncertainty	Uncertainty of shear (S) wave velocity		m/s

Field	Description	Restrictions to values	Unit
layerCount	Number of layers for a given velocity profile		
Child elements of <FileResource>			
URL	URL of the report file		
Description	Description of the FileResource		

Conclusion

Given the lack of already running site characterization databases at network operators level, we propose a strategy to communicate site characterization information among the network operators and European services (European Geotechnical Database, EGD; ORFEUS StationBook, ESM) based on the already existing standard FDSN Web Service Station response (StationXML). We first define a site characterization metadata file (SiteXML) that includes both required site characterization information by EGD and site characterization indicators resulting from the international questionnaires and workshop conducted in SERA Task7.2. SiteXML schema closely follows the one proposed in QuakeML2.0 draft for site characterization and the one developed by EGD.

Hosted by the network operator of an authoritative data center, the URL of SiteXML is introduced in the <ExternalReference> element in the StationXML structure. Site characterization metadata can then be retrieved in real-time by any end-users or service and the extracted site characterization information can be exposed in, e.g. EGD, ORFEUS-StationBook or ESM service.

This strategy is probably not the most sustainable one, but the most pragmatic and flexible one to achieve a short-term communication of the already existing site characterization information, while waiting for network operators to set up and run dedicated site characterization databases.

The SiteXML schema and XML sample has been exposed by RESIF. Retrieve of the site characterization information from SiteXML is under current testing by ORFEUS and EGD before going to production phase for the RESIF stations (33 stations; Hollender et al., 2018) and large dissemination of the procedure among network operators.

Appendix 1. Sample of Site.XML

SiteXML sample for permanent station OGPC (RESIF, RA network). Reported site characterization information are mostly coming from Hollender et al. (2018). For sake of clarity, only one V_s profile is indicated. The complete SiteXML file is available here: https://gitlab.com/resif/site-characterization/-/blob/master/XML/SiteOGPC_SERA_v1.2.xml

```
<?xml version="1.0" encoding="UTF-8"?>
<!--Sample XML file generated by XMLSpy v2020 rel. 2 (x64) (http://www.altova.com)-->
<!--This .xml file has been created to exchange information on site characterization information
for permanent seismological station. The content of the .kml file is based on QuakeML description
(https://quake.ethz.ch/quakeml/QuakeML2.0) and EGD level1 description. The content fulfills required
information by the European Geotechnical Database (EGD) and by EU-SERA. -->
<SERA_quakeml xmlns="https://gitlab.com/resif/site-characterization/-/tree/master/schema"
xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance">
```

<!--Information on the owner of site characterization information -->

```
  <siteOwner publicID="String">
    <codeName>ISTERRE</codeName>
    <fullName>Institut des Sciences de la Terre</fullName>
    <contact>
      <person personID="quakeml:isterre.fr/person/001">
        <firstName>Cecile</firstName>
        <lastName>Cornou</lastName>
        <mbox>mailto:cecile.cornou@univ-grenoble-alpes.fr</mbox>
        <homepage>https://www.isterre.fr/annuaire/pages-web-du-personnel/cecile-
cornou</homepage>
      </person>
      <affiliation>
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              <code>FR</code>
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          </postalAddress>
        </institution>
        <department>ISTERRE</department>
        <function>Senior researcher</function>
      </affiliation>
    </contact>
  </siteOwner>
  <siteCharacterizationParameters publicID="String">
    <Analysis publicID="String">
```

<!--Resonance Frequency -->

```
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      <uncertainty></uncertainty>
    </resonanceFrequency>
    <resonanceFrequencyQindex1>
```

```

        <value></value>
</resonanceFrequencyQindex1>
<!-- Additional information needed for EGD -->
<resonanceFrequencyMethod></resonanceFrequencyMethod>
<resonanceFrequencyMethod></resonanceFrequencyMethod>
<!-- End of additional information needed for EGD -->
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  <literatureSource>
    <title></title>
    <firstAuthor></firstAuthor>
    <secondaryAuthors></secondaryAuthors>
    <secondaryAuthors></secondaryAuthors>
    <year></year>
    <booktitle></booktitle>
    <language>
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    <DOI></DOI>
  </literatureSource>
  <FileResource>
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  </FileResource>
</resonanceFrequencyReference>

<!-- Vs30 -->

<velocityS30>
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  <uncertainty>18</uncertainty>
</velocityS30>
<velocityS30Qindex1>
  <value>0.5</value>
</velocityS30Qindex1>
<!-- Additional information needed for EGD -->
<velocityS30Method>Active non-invasive S-wave methods</velocityS30Method>
<velocityS30Method>Passive non-invasive S-wave methods</velocityS30Method>
<velocityS30MethodCombIndex>1.2</velocityS30MethodCombIndex>
<velocityS30ManualIndex>1</velocityS30ManualIndex>
<!-- End of additional information needed for EGD -->
<velocityS30Reference>
  <literatureSource>
    <title>Characterization of site conditions (soil class, Vs30, velocity profiles) for 33
stations from the French permanent accelerometric network (RAP) using surface-wave methods</title>
    <firstAuthor>Hollender F.</firstAuthor>
    <secondaryAuthors></secondaryAuthors>
    <year>2018</year>
    <booktitle>Bulletin Earthquake Engineering</booktitle>
    <language>
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    <description>paper</description>
    <url>https://doi.org/10.1007/s10518-017-0135-5</url>
  </FileResource>
</velocityS30Reference>

<!-- Additional parameters needed for EGD -->
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</cptLogsCount>
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</Analysis>
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</VelocityProfile>
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</velocityProfileQindex1>
<velocityProfileReference>
    <literatureSource>
        <title>Characterization of site conditions (soil class, Vs30, velocity profiles) for 33 stations from
the French permanent accelerometric network (RAP) using surface-wave methods</title>
        <firstAuthor>Hollender F.</firstAuthor>
        <secondaryAuthors></secondaryAuthors>
        <year>2018</year>
        <booktitle>Bulletin Earthquake Engineering</booktitle>
        <language>
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        <description>paper</description>
        <url>https://doi.org/10.1007/s10518-017-0135-5</url>
    </FileResource>
    </velocityProfileReference>
</siteCharacterizationParameters>
<siteDescription>
<!-- Latitude and longitude (central location) of site characterization meas. -->
    <latitude>

```

```

        <value>45.137174</value>
    </latitude>
    <longitude>
        <value>5.998905</value>
    </longitude>
    <altitude>
        <value>239</value>
    </altitude>
    <minDistanceFromStation>
        <value></value>
    </minDistanceFromStation>
    <maxDistanceFromStation>
        <value></value>
    </maxDistanceFromStation>
    <siteMorphology>
<!-- EC8 ground type -->
    <siteClassEC8>B</siteClassEC8>
    <siteClassEC8Qindex1>
        <value>1</value>
    </siteClassEC8Qindex1>
    <siteClassEC8Reference>
        <literatureSource>
            <title>Characterization of site conditions (soil class, Vs30, velocity profiles) for 33
stations from the French permanent accelerometric network (RAP) using surface-wave methods</title>
            <firstAuthor>Hollender F.</firstAuthor>
            <secondaryAuthors></secondaryAuthors>
            <year>2018</year>
            <booktitle>Bulletin Earthquake Engineering</booktitle>
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        </literatureSource>
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<!-- Engineering bedrock depth -->
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    </h800>
    <h800Qindex1>

```

```

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            <secondaryAuthors></secondaryAuthors>
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            <description></description>
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    </h800Reference>
<!-- Surface geology (more detailed than in <Geology> element of StationXML) -->

    <geologicalUnit>Recent alluvial and lacustrine deposits valley overlying deep
Jurassic limestones</geologicalUnit>
    <geologicalUnitQindex1>
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