The improvement of confidence levels could be achieved with the inclusion of more accelerometric data with sufficient magnitude values and the most rigorous homogenization of the magnitude scales.

Another proposal of future works is to extend the comparisons of accelerometric data to the whole Mediterranean area. This will allow us to verify if the observed behaviors must be atributed to the magnitude range or if the Mediterranean area has a regional behavior.

The NERIES project (Network of Research Infraestructures for European Seismology, FP6-2004-infraestructures-5, 2006-2009) can help in the next future in this aspect, because the definition of protocols and communication system that will allow to access easily to the European accelerometric data is being carried out. This database will concentrate a huge quantity of European data. This availability of European accelerometric data will be an important goal to develop new ground motion predictive equations.

- *Local scale:*

The Benchmark exercise analysis at the Volvi valley has been completed. The extracted conclusions are very useful for future local effects studies in other regions. However, other Benchmark exercises will be useful to generalize these conclusions.

Important consequences from the analysis of the Benchmark exercise is the application of one of the proposed theoretical methodologies to the Pyrenean valley of Cerdanya. The results presented in this thesis (chapter 5) constitute a beginning of a comparative study. It is necessary to perform more seismic modelling methods in the valley for such purpose.

Also, more geophysical experiments are needed to provide accurate geophysical data that describe the valley structure in a more realistic way, fact that will provide more reliability to the modeling results.

According to the seismic modeling, future works would be focused in the accomplishment of computations using real input motions. Also, it is interesting the use more realistic sources to study directivity effects according to the location of the sources with respect to the valley.

To validate the seismic modeling it would be also needed to dispose of real seismic records in the area. This will allow to make comparisons between the simulated motions and the real ones. This implies the need of deploying strong ground motion instrumentation in the area with surface and borehole instruments.

The future application of numerical modeling in other 2D profiles in the valley as well as the creation of a 3D model for the application of 3D modeling of the Cerdanya valley will be of great interest and will improve the results.

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Apéndices

Apéndice A:

Atenuación sísmica en la parte Oeste de la vertiente mediterránea

Tabla A.1. Listado de los registros utilizados para el estudio de atenuación sísmica.

Año	Mes	Día	Tiempo (UTC)	Latitud	Longitud	Área epicentral	h (km)	M_L	Distancia epicentral (km)	Estación	Agencia
1997	09	26	00:33:12	43º01’05”N	12º52’52”E	Umbria-Marche (Italy)	6.9	5.6	4	Colfiorito	SSN-Enel, 1998
									13	Nocera Umbra	SSN-Enel, 1998
									23	Assisi Stallone	SSN-Enel, 1998
									24	Bevagna	SSN-Enel, 1998
									24	Catelnuovo	SSN-Enel, 1998
									25	Monte Fiegni	SSN-Enel, 1998
									28	Matelica	SSN-Enel, 1998
									35	Cascia	SSN-Enel, 1998
									35	Spoleto Monteluco	SSN-Enel, 1998
									39	Forca Canapine	SSN-Enel, 1998
									40	Gubbio (Piana)	SSN-Enel, 1998
									51	Leonessa	SSN-Enel, 1998
									66	Rieti	SSN-Enel, 1998
									86	Aquilpark Citta	SSN-Enel, 1998
									86	Aquilpark Galleria	SSN-Enel, 1998
									86	Aquilpark Parcheggio	SSN-Enel, 1998
									126	Borgo Ottomila-2	SSN-Enel, 1998
1997	09	26	09:40:26	43º01’45”N	12º51’04”E	Umbria-Marche (Italy)	8.0	6.0	6	Colfiorito	SSN-Enel, 1998

Año	Mes	Día	Tiempo (UTC)	Latitud	Longitud	Área epicentral	h (km)	M_L	Distancia epicentral (km)	Estación	Agencia
									11	Nocera Umbra	SSN-Enel, 1998
									20	Assissi Stallone	SSN-Enel, 1998
									21	Castelnuovo	SSN-Enel, 1998
									22	Bevagna	SSN-Enel, 1998
									27	Monte Fiegni	SSN-Enel, 1998
									28	Matelica	SSN-Enel, 1998
									37	Cascia	SSN-Enel, 1998
									38	Gubbio (Piana)	SSN-Enel, 1998
									42	Forca Canapine	SSN-Enel, 1998
									42	Gubbio	SSN-Enel, 1998
									53	Leonessa	SSN-Enel, 1998
									55	Pietralunga	SSN-Enel, 1998
									59	Cagli	SSN-Enel, 1998
									67	Rieti	SSN-Enel, 1998
									79	Peglio	SSN-Enel, 1998
									79	Senigallia	SSN-Enel, 1998
									83	Valle Aterno-Colle	SSN-Enel, 1998
									88	Aquilpark Ciitta	SSN-Enel, 1998
									88	Aquilpark Galleria	SSN-Enel, 1998
									88	Aquilpark Parcheggio	SSN-Enel, 1998

Año	Mes	Día	Tiempo (UTC)	Latitud	Longitud	Área epicentral	h (km)	M_L	Distancia epicentral (km)	Estación	Agencia
									100	Pennabilli	SSN-Enel, 1998
									126	Borgo Ottomila-2	SSN-Enel, 1998
1997	10	06	23:24:52	42º59'55"N	12º49'27"	Umbria-Marche (Italy)		5.4	7	Colfiorito (Casermette)	SSN-Enel, 1998
									9	Colfiorito	SSN-Enel, 1998
									12	Nocera Umbra (Biscon.)	SSN-Enel, 1998
									13	Nocera Umbra	SSN-Enel, 1998
									13	Nocera Umbra-2	SSN-Enel, 1998
									17	Nocera Umbra (Salmata)	SSN-Enel, 1998
									19	Bevagna	SSN-Enel, 1998
									19	Castelnuovo	SSN-Enel, 1998
									20	Assesi Stallone	SSN-Enel, 1998
									30	Monte Fiegni	SSN-Enel, 1998
									32	Norcia	SSN-Enel, 1998
									35	Cascia	SSN-Enel, 1998
									40	Gubbio (Piana)	SSN-Enel, 1998
									41	Forca Canapine	SSN-Enel, 1998
									44	Gubbio	SSN-Enel, 1998
									50	Leonessa	SSN-Enel, 1998
									63	Rieti	SSN-Enel, 1998
									87	Aquilpark Citta	SSN-Enel, 1998

Año	Mes	Día	Tiempo (UTC)	Latitud	Longitud	Área epicentral	h (km)	M_L	Distancia epicentral (km)	Estación	Agencia
									87	Aquilpark Galleria	SSN-Enel, 1998
									87	Aquilpark Parcheggio	SSN-Enel, 1998
1997	10	14	15:23:00	42º54’39”N	12º55’42 E	Umbria-Marche (Italy)		5.5	10	Cesi Monte	SSN-Enel, 1998
									13	Colfiorito (Casermette)	SSN-Enel, 1998
									14	Colfiorito	SSN-Enel, 1998
									17	Annifo	SSN-Enel, 1998
									18	Cassignano	SSN-Enel, 1998
									18	Serravalle di Chienti	SSN-Enel, 1998
									19	Norcia	SSN-Enel, 1998
									22	Cascia	SSN-Enel, 1998
									24	Nocera Umbra (Biscon.)	SSN-Enel, 1998
									25	Nocera Umbra	SSN-Enel, 1998
									25	Spoleto Monteluco	SSN-Enel, 1998
									25	Nocera Umbra-2	SSN-Enel, 1998
									26	Bevagna	SSN-Enel, 1998
									27	Monte Fiegni	SSN-Enel, 1998
									28	Forca Canapine	SSN-Enel, 1998
									29	Nocera Umbra (Salmata)	SSN-Enel, 1998
									29	Castelnuovo (Assisi)	SSN-Enel, 1998
									32	Assisi Stallone	SSN-Enel, 1998

Año	Mes	Día	Tiempo (UTC)	Latitud	Longitud	Área epicentral	h (km)	M_L	Distancia epicentral (km)	Estación	Agencia
									38	Matelica	SSN-Enel, 1998
									39	Leonessa	SSN-Enel, 1998
									52	Gubbio (Piana)	SSN-Enel, 1998
									54	Rieti	SSN-Enel, 1998
									68	Valle Aterno-Moro	SSN-Enel, 1998
									68	Valle Aterno-Valle	SSN-Enel, 1998
									68	Valle Aterno-Fiume	SSN-Enel, 1998
									69	Valle Aterno-M.Pettino	SSN-Enel, 1998
									74	Aquilpark Citta	SSN-Enel, 1998
									74	Aquilpark Galleria	SSN-Enel, 1998
									74	Aquilpark Parcheggio	SSN-Enel, 1998
									126	Borgo Ottomila-2	SSN-Enel, 1998
1993	12	23	14:22	36º46.8'N	02º56.2'W	Adra (S. Spain)		5.0(m_b)	7.5	Adra (AL)	IGN, 2005
									54.1	Motril (GR)	IGN, 2005
									73.0	Comares (Alhambra, GR)	IGN, 2005
									75.1	Fac. Ciencias (GR)	IGN, 2005
									81.2	Albolote (GR)	IGN, 2005
									81.2	Jayena (GR)	IGN, 2005
									96.7	Alhama (GR)	IGN, 2005
									108.1	Vera (AL)	IGN, 2005

Año	Mes	Día	Tiempo (UTC)	Latitud	Longitud	Área epicentral	h (km)	M_L	Distancia epicentral (km)	Estación	Agencia
1994	01	04	08:03	36º34.3’N	02º48.9’W	Adra (S. Spain)		4.9(m_b)	26.6	Adra (AL)	IGN, 2005
									44.5	Almería (AL)	IGN, 2005
									67.1	Motril (GR)	IGN, 2005
									96.6	Comares (Alhambra, GR)	IGN, 2005
									98.4	Fac. Ciencias (GR)	IGN, 2005
									104.7	Albolote (GR)	IGN, 2005
									112.7	Vera (AL)	IGN, 2005
									114.9	Alhama (GR)	IGN, 2005
1996	02	18	01:45	42º 47.66' N	02º 32.05' E	Sant Pau de Fenollet (Pyrénées Orientales, France)	8	5.2	8	Agly	Presa
									70.1	Olot (GI)	IGN and ICC, 2005
									389.3	OGGM	GIS-RAP, 2005
1996	09	02	19 :07	37º32.5’N	01º30.4’W	Mazarrón (S.Spain)	2	4.5(m_b)	22.8	Lorca (MU)	IGN, 2005
									87.9	Torrevieja (A)	IGN, 2005
									45.9	Vera (AL)	IGN, 2005
1997	07	02	09:38	36º23.8’N	03º09.0’W	Adra (S.Spain)	1	4.6(m_b)	63.4	Ugijar (GR)	IGN, 2005
									75.3	úrcal (GR)	IGN, 2005
									85.9	Jayena (GR)	IGN, 2005
1997	07	02	12:53	36º25.68’N	03º15.17’W	Adra (S.Spain)	2	4.4(m_b)	41.8	Adra (AL)	IGN, 2005

Año	Mes	Día	Tiempo (UTC)	Latitud	Longitud	Área epicentral	h (km)	M_L	Distancia epicentral (km)	Estación	Agencia
									42.2	Motril (GR)	IGN, 2005
									61.9	Ugijar (GR)	IGN, 2005
									68.0	□úrcal (GR)	IGN, 2005
									77.1	Jayena (GR)	IGN, 2005
1999	02	02	13:45	38.1100N	1.4900W	Mula (S.Spain)	4	4.8(m_b)	21.1	Lorquí (MU)	IGN, 2005
									43.3	Jumilla (MU)	IGN, 2005
									47.5	Orihuela (A)	IGN, 2005
									51.4	Lorca (MU)	IGN, 2005
									71.5	Torrevieja (A)	IGN, 2005
									110.4	Alcoy (A)	IGN, 2005
1999	10	04	18:14	42.7900 N	0.5800 W	B de Luchon (S. France)	10.2	4.5(m_b)	20.3	Vielha (L)	IGN and ICC, 2005
2001	02	25	18:34:42.93	43.49 N	7.47 E	Nice (France)	14	4.7	26.1	NBOR	GIS-RAP, 2005
									27.7	NPOR	GIS-RAP, 2005
									28.9	NROC	GIS-RAP, 2005
									28.9	NALS	GIS-RAP, 2005
									29.6	NLIB	GIS-RAP, 2005
									32.7	MENA	GIS-RAP, 2005
									53.0	CALF	GIS-RAP, 2005
									55.5	SAOF	GIS-RAP, 2005
									95.9	STET	GIS-RAP, 2005

Año	Mes	Día	Tiempo (UTC)	Latitud	Longitud	Área epicentral	h (km)	M_L	Distancia epicentral (km)	Estación	Agencia
									121.4	OG□I	GIS-RAP, 2005
									123.0	IRVA	GIS-RAP, 2005
									128.2	IRSE	GIS-RAP, 2005
									138.5	IRVL	GIS-RAP, 2005
									139.0	IRCA	GIS-RAP, 2005
									141.5	IRMA	GIS-RAP, 2005
									142.8	IRSP	GIS-RAP, 2005
									144.9	IRPV	GIS-RAP, 2005
									167.7	RUSF	GIS-RAP, 2005
									173.8	ARBF	GIS-RAP, 2005
									198.2	OGBB	GIS-RAP, 2005
									200.3	OGMO	GIS-RAP, 2005
									218.9	OGGM	GIS-RAP, 2005
									219.6	OGAV	GIS-RAP, 2005
									232.0	OGFB	GIS-RAP, 2005
									232.0	OGFH	GIS-RAP, 2005
									233.2	OGCU	GIS-RAP, 2005
									235.1	OGMU	GIS-RAP, 2005
									240.4	OGLE	GIS-RAP, 2005
									254.3	OGCH	GIS-RAP, 2005

Año	Mes	Día	Tiempo (UTC)	Latitud	Longitud	Área epicentral	h (km)	M_L	Distancia epicentral (km)	Estación	Agencia
									269.0	OGBL	GIS-RAP, 2005
									287.3	OGAN	GIS-RAP, 2005
									526.6	STSM	GIS-RAP, 2005
2002	02	04	20:09	37.09N	2.54W	Gergal (AL)	0	5.2(m_b)	14.8	Alhama de Almería (AL)	IGN, 2005
									27.3	Almería (AL)	IGN, 2005
									27.3	Almería (AL)	IGN, 2005
									41.8	El Ejido(AL)	IGN, 2005
									56.4	Adra (AL)	IGN, 2005
									57.7	Guadix (GR)	IGN, 2005
2002	05	16	14:56:33.64	42.94N	0.16W	Aucun (France)	10	4.8	15.2	PYLS	GIS-RAP, 2005
									19.8	PYLO	GIS-RAP, 2005
									27.9	PYA□	GIS-RAP, 2005
									48.1	PYA	GIS-RAP, 2005
									64.4	PYLU	GIS-RAP, 2005
									90.9	PYPP	GIS-RAP, 2005
									106.0	PYLI	GIS-RAP, 2005
									144.3	PYFO	GIS-RAP, 2005
									173.1	PYBE	GIS-RAP, 2005
									181.9	Llívia-2(L2)	GIS-RAP, 2005
									215.0	PYPR	GIS-RAP, 2005

Año	Mes	Día	Tiempo (UTC)	Latitud	Longitud	Área epicentral	h (km)	M_L	Distancia epicentral (km)	Estación	Agencia
									218.4	PYFE	GIS-RAP, 2005
									220.9	PYPM	GIS-RAP, 2005
									250.4	PYPE	GIS-RAP, 2005
									273.5	PYBA	GIS-RAP, 2005
2002	05	16	15:14:44.57	42.82N	0.15W	Aucun (France)	10	4.2	12.4	PYLS	GIS-RAP, 2005
									32.0	PYLO	GIS-RAP, 2005
									38.2	PYA□	GIS-RAP, 2005
									55.1	PYAT	GIS-RAP, 2005
									61.5	PYLU	GIS-RAP, 2005
									107.0	PYLI	GIS-RAP, 2005
									144.5	PYFO	GIS-RAP, 2005
									172.0	PYBE	GIS-RAP, 2005
									212.6	PYPR	GIS-RAP, 2005
									217.2	PYPM	GIS-RAP, 2005
									217.4	PYFE	GIS-RAP, 2005
									248.6	PYPE	GIS-RAP, 2005
2002	08	06	06:16:18	37.88N	1.83W	Bullas (S. Spain)	2	4.8(m_b)	27.8	Lorca (MU)	IGN, 2005
									32.5	Mula (MU)	IGN, 2005
									53.6	Lorquí (MU)	IGN, 2005
									62.9	Murcia (MU)	IGN, 2005

Año	Mes	Día	Tiempo (UTC)	Latitud	Longitud	Área epicentral	h (km)	M_L	Distancia epicentral (km)	Estación	Agencia
									73.7	Vera(AL)	IGN, 2005
									130.2	Olula del Río (AL)	IGN, 2005
									172.9	Jaén (J)	IGN, 2005
2002	08	24	10:08:08	36.39N	4.60W	Málaga (S. Spain)	69	4.2(m_b)	41.1	Málaga (MA)	IGN, 2005
2002	12	11	20:09:52.15	43.04N	0.33W	Pau (France)	5	4.4	10.1	PYA□	GIS-RAP, 2005
									31.6	PYAT	GIS-RAP, 2005
									33.0	PYLS	GIS-RAP, 2005
									152.8	PYOR	GIS-RAP, 2005
2002	12	12	17:59:49.55	43.11N	0.28W	Pau (France)	10	4.6	12.0	PYA□	GIS-RAP, 2005
									18.9	PYLO	GIS-RAP, 2005
									35.1	PYAT	GIS-RAP, 2005
									35.5	PYLS	GIS-RAP, 2005
									116.0	PILI	GIS-RAP, 2005
									150.4	PYOR	GIS-RAP, 2005
									197.2	Llívia-2 (L2)	ICC, 2005
									235.6	PYPM	GIS-RAP, 2005
									262.6	PYPE	GIS-RAP, 2005
									270.2	PYPT	GIS-RAP, 2005
2003	01	21	18:00:59	43.05N	0.36W	Pau (France)	10	4.4	7.6	PYA□	GIS-RAP, 2005

Año	Mes	Día	Tiempo (UTC)	Latitud	Longitud	Área epicentral	h (km)	M_L	Distancia epicentral (km)	Estación	Agencia
									26.0	PYLO	GIS-RAP, 2005
									29.0	PYAT	GIS-RAP, 2005
									35.6	PYLS	GIS-RAP, 2005
									72.7	PYPP	GIS-RAP, 2005
									94.4	PYAS	GIS-RAP, 2005
									155.4	PYOR	GIS-RAP, 2005
									233.2	PYPR	GIS-RAP, 2005
									235.6	PYFE	GIS-RAP, 2005
									239.9	PYPM	GIS-RAP, 2005
									268	PYPE	GIS-RAP, 2005
									276.7	PYPT	GIS-RAP, 2005
									539.3	OGRS	GIS-RAP, 2005
									542.4	OGMU	GIS-RAP, 2005
2003	01	24	20 :35 :01	37.76N	4.63W	Espejo (S. Spain)	7	4.6(m_b)	19.1	Montilla (CO)	IGN, 2005
									46.6	Ecija (SE)	IGN, 2005
									74.1	Jaén (J)	IGN, 2005
2003	02	18	13:09:37	35.80N	3.46W	Alborán (S. Spain)	168	4.6(m_b)	103.5	Motril (GR)	IGN, 2005
									125.9	Jayena (GR)	IGN, 2005
2003	02	26	03:32:57.2	42.30 N	2.22 E	Ripolles (Spain)	7	3.8	22.4	PYPM	GIS-RAP, 2005
									27.3	Llívia-2 (L2)	ICC, 2005

Año	Mes	Día	Tiempo (UTC)	Latitud	Longitud	Área epicentral	h (km)	M_L	Distancia epicentral (km)	Estación	Agencia
									38.5	PYPR	GIS-RAP, 2005
									61.4	PYFE	GIS-RAP, 2005
									67.9	PYPE	GIS-RAP, 2005
									71.7	Celoni-2 (C2)	ICC, 2005
									76.2	PYBA	GIS-RAP, 2005
									78.6	Celoni-1 (C1)	ICC, 2005
									78.9	PYOR	GIS-RAP, 2005
									103.0	PYPT	GIS-RAP, 2005
									117.6	PILI	GIS-RAP, 2005
									117.8	Olot (O)	ICC and IGN, 2005
									140.3	PYAS	GIS-RAP, 2005
									192.8	PYLS	GIS-RAP, 2005
									205.6	PYLO	GIS-RAP, 2005
									233.9	PYA□	GIS-RAP, 2005
									255.2	PYAT	GIS-RAP, 2005
									282.6	BRGM	GIS-RAP, 2005
2003	09	21	10:34:16	39.42N	0.01W	Valencia (Spain)	10	4.6(M_{bLg})	31.4	Puig (V)	IGN, 2005
									50.3	Gandía (V)	IGN, 2005
2004	03	07	06:37	35.04 N	4.02 W	Alhucemas	-	5.0(M_{bLg})	8	CME□ (temporal st.)	ICC, 2005
									8	GAS (temporal st.)	ICC, 2005

Año	Mes	Día	Tiempo (UTC)	Latitud	Longitud	Área epicentral	h (km)	M_L	Distancia epicentral (km)	Estación	Agencia
2004	09	21	15:48:04.8	42.34 N	2.17 E	Ripollés (Spain)	4	4.0	55.8	Andorra	Crecit, 2005
									76.9	Celoni-1 (C1)	ICC, 2005
									78.2	Celoni-2(C2)	ICC, 2005
									22.6	Llívia-1 (L1)	ICC, 2005
									21.2	Llívia-2 (L2)	ICC, 2005
									111.6	PILI	GIS-RAP, 2005
									15.2	PYLL	GIS-RAP, 2005
									36.8	PYPR	GIS-RAP, 2005
									59.1	PYFE	GIS-RAP, 2005
									68.7	PYPE	GIS-RAP, 2005
									72.8	PYOR	GIS-RAP, 2005
									79.3	PYBA	GIS-RAP, 2005
									83.6	PYFO	GIS-RAP, 2005
									102.3	PYPT	GIS-RAP, 2005
									134.4	PYAS	GIS-RAP, 2005
									179.2	PYCA	GIS-RAP, 2005
									187.4	PYLS	GIS-RAP, 2005
									199.9	PYLO	GIS-RAP, 2005
									249.8	PYAT	GIS-RAP, 2005
									353.1	OCC□	GIS-RAP, 2005

Año	Mes	Día	Tiempo (UTC)	Latitud	Longitud	Área epicentral	h (km)	M_L	Distancia epicentral (km)	Estación	Agencia
									381.7	OG□I	GIS-RAP, 2005
									56.3	PYBE	GIS-RAP, 2005
									461.0	OGCH	GIS-RAP, 2005
									505.7	OGAN	GIS-RAP, 2005
									31.7	Olot (O)	ICC and IGN, 2005

Tabla A.2. Coeficientes de la ecuación predictiva de las ordenadas del espectro de aceleración, SA, ($\log_{10} SA_H(f) = C_1(f) + C_2(f) \cdot M_L - \log_{10} r + C_4(f) \cdot r \pm \sigma$) para h_o = 10 km. El PGA y el SA están expresados en cm/s^2.

h_o = 10 m					
T(s)	**Freq (Hz)**	**C1(freq)**	**C2(freq)**	**C4 (freq)**	**Sigma**
10.0000	0.1000	-3.7	0.69	0.0011	0.598
9.0090	0.1110	-3.7	0.72	0.0009	0.589
8.0000	0.1250	-3.8	0.76	0.0008	0.584
6.9930	0.1430	-3.9	0.80	0.0007	0.589
5.9880	0.1670	-3.9	0.85	0.0006	0.590
5.4945	0.1820	-4.0	0.88	0.0005	0.592
5.0000	0.2000	-4.1	0.93	0.0004	0.593
4.5045	0.2220	-4.1	0.93	0.0003	0.595
4.0000	0.2500	-4.1	0.96	0.0002	0.604
3.8023	0.2630	-4.1	0.97	0.0001	0.606
3.5971	0.2780	-4.1	0.98	0.0000	0.606
3.4014	0.2940	-4.1	0.99	0.0000	0.603
3.3333	0.3000	-4.1	0.98	0.0000	0.602
3.2051	0.3120	-4.1	0.99	0.0000	0.603
3.0030	0.3330	-4.1	1.01	0.0000	0.603
2.8011	0.3570	-4.0	1.01	-0.0001	0.597
2.5974	0.3850	-4.1	1.02	-0.0001	0.589
2.5000	0.4000	-4.1	1.04	-0.0002	0.586
2.3981	0.4170	-4.1	1.04	-0.0002	0.584
2.1978	0.4550	-4.0	1.04	-0.0003	0.575
2.0000	0.5000	-3.9	1.05	-0.0004	0.577
1.7986	0.5560	-3.9	1.07	-0.0005	0.582
1.6667	0.6000	-3.9	1.08	-0.0006	0.582
1.6000	0.6250	-3.9	1.09	-0.0007	0.584
1.4993	0.6670	-3.8	1.09	-0.0008	0.585
1.4286	0.7000	-3.7	1.09	-0.0008	0.584
1.4006	0.7140	-3.7	1.09	-0.0008	0.584
1.3004	0.7690	-3.7	1.10	-0.0009	0.590
1.2500	0.8000	-3.6	1.10	-0.0009	0.590
1.2005	0.8330	-3.6	1.09	-0.0010	0.588
1.1111	0.9000	-3.4	1.08	-0.0010	0.581
1.1001	0.9090	-3.4	1.08	-0.0010	0.580
1.0000	1.0000	-3.3	1.06	-0.0011	0.576
0.9091	1.1000	-3.2	1.07	-0.0012	0.569
0.9001	1.1110	-3.2	1.07	-0.0012	0.568
0.8503	1.1760	-3.2	1.07	-0.0012	0.566

T(s)	Freq (Hz)	C1(freq)	C2(freq)	C4 (freq)	Sigma
0.8333	1.2000	-3.2	1.07	-0.0012	0.567
0.8000	1.2500	-3.1	1.05	-0.0013	0.569
0.7692	1.3000	-3.0	1.04	-0.0013	0.571
0.7502	1.3330	-2.9	1.03	-0.0013	0.569
0.7143	1.4000	-2.8	1.02	-0.0014	0.560
0.6998	1.4290	-2.8	1.02	-0.0014	0.556
0.6798	1.4710	-2.7	1.01	-0.0014	0.548
0.6667	1.5000	-2.7	1.01	-0.0015	0.544
0.6601	1.5150	-2.7	1.00	-0.0015	0.543
0.6402	1.5620	-2.6	1.00	-0.0015	0.539
0.6250	1.6000	-2.6	1.00	-0.0015	0.536
0.6200	1.6130	-2.6	0.99	-0.0015	0.534
0.5999	1.6670	-2.5	0.99	-0.0015	0.532
0.5882	1.7000	-2.5	0.99	-0.0016	0.531
0.5800	1.7240	-2.5	0.98	-0.0016	0.530
0.5599	1.7860	-2.4	0.98	-0.0016	0.528
0.5556	1.8000	-2.4	0.98	-0.0016	0.527
0.5400	1.8520	-2.4	0.98	-0.0017	0.523
0.5263	1.9000	-2.4	0.97	-0.0017	0.518
0.5200	1.9230	-2.4	0.97	-0.0017	0.516
0.5000	2.0000	-2.3	0.96	-0.0017	0.509
0.4801	2.0830	-2.2	0.95	-0.0018	0.505
0.4762	2.1000	-2.2	0.94	-0.0018	0.504
0.4600	2.1740	-2.1	0.93	-0.0019	0.502
0.4545	2.2000	-2.0	0.92	-0.0019	0.501
0.4399	2.2730	-1.9	0.90	-0.0019	0.499
0.4348	2.3000	-1.9	0.90	-0.0019	0.498
0.4200	2.3810	-1.8	0.88	-0.0019	0.492
0.4167	2.4000	-1.7	0.87	-0.0019	0.491
0.4000	2.5000	-1.6	0.85	-0.0019	0.484
0.3846	2.6000	-1.5	0.84	-0.0020	0.479
0.3799	2.6320	-1.5	0.83	-0.0020	0.477
0.3704	2.7000	-1.5	0.82	-0.0020	0.474
0.3600	2.7780	-1.4	0.81	-0.0021	0.474
0.3571	2.8000	-1.4	0.81	-0.0021	0.473
0.3448	2.9000	-1.2	0.79	-0.0021	0.470
0.3400	2.9410	-1.2	0.78	-0.0021	0.469
0.3333	3.0000	-1.1	0.77	-0.0021	0.468
0.3200	3.1250	-1.0	0.75	-0.0022	0.464
0.3170	3.1550	-1.0	0.75	-0.0022	0.463
0.3030	3.3000	-0.9	0.73	-0.0023	0.457

T(s)	Freq (Hz)	C1(freq)	C2(freq)	C4 (freq)	Sigma
0.3000	3.3330	-0.9	0.73	-0.0023	0.457
0.2900	3.4480	-0.9	0.72	-0.0023	0.456
0.2800	3.5710	-0.8	0.72	-0.0024	0.456
0.2778	3.6000	-0.8	0.72	-0.0024	0.455
0.2632	3.8000	-0.7	0.70	-0.0025	0.449
0.2597	3.8500	-0.7	0.70	-0.0025	0.448
0.2500	4.0000	-0.6	0.68	-0.0025	0.444
0.2400	4.1670	-0.5	0.66	-0.0026	0.442
0.2381	4.2000	-0.5	0.66	-0.0026	0.442
0.2273	4.4000	-0.4	0.65	-0.0027	0.440
0.2198	4.5500	-0.3	0.64	-0.0027	0.438
0.2174	4.6000	-0.3	0.63	-0.0027	0.438
0.2083	4.8000	-0.2	0.62	-0.0027	0.435
0.2000	5.0000	-0.1	0.61	-0.0028	0.435
0.1905	5.2500	-0.1	0.59	-0.0028	0.435
0.1900	5.2630	0.0	0.59	-0.0028	0.435
0.1818	5.5000	0.1	0.56	-0.0029	0.432
0.1800	5.5560	0.1	0.55	-0.0029	0.431
0.1739	5.7500	0.3	0.52	-0.0029	0.427
0.1700	5.8820	0.3	0.51	-0.0029	0.427
0.1667	6.0000	0.4	0.50	-0.0029	0.427
0.1600	6.2500	0.4	0.49	-0.0029	0.427
0.1538	6.5000	0.5	0.48	-0.0029	0.429
0.1500	6.6670	0.5	0.47	-0.0029	0.432
0.1481	6.7500	0.6	0.46	-0.0029	0.433
0.1429	7.0000	0.7	0.43	-0.0030	0.431
0.1400	7.1430	0.8	0.42	-0.0030	0.429
0.1379	7.2500	0.8	0.42	-0.0030	0.429
0.1333	7.5000	0.9	0.40	-0.0031	0.428
0.1300	7.6920	0.9	0.40	-0.0031	0.428
0.1290	7.7500	0.9	0.40	-0.0032	0.428
0.1250	8.0000	1.0	0.39	-0.0032	0.426
0.1200	8.3330	1.0	0.38	-0.0033	0.428
0.1176	8.5000	1.0	0.38	-0.0033	0.428
0.1111	9.0000	1.1	0.36	-0.0033	0.429
0.1100	9.0910	1.1	0.36	-0.0033	0.430
0.1053	9.5000	1.1	0.35	-0.0033	0.433
0.1000	10.0000	1.1	0.35	-0.0033	0.438
0.0952	10.5000	1.1	0.35	-0.0033	0.446
0.0909	11.0000	1.1	0.35	-0.0033	0.445
0.0900	11.1110	1.1	0.35	-0.0034	0.445

T(s)	Freq (Hz)	C1(freq)	C2(freq)	C4 (freq)	Sigma
0.0870	11.5000	1.1	0.35	-0.0034	0.442
0.0850	11.7650	1.1	0.34	-0.0034	0.441
0.0833	12.0000	1.1	0.34	-0.0034	0.441
0.0800	12.5000	1.1	0.34	-0.0035	0.445
0.0769	13.0000	1.1	0.34	-0.0035	0.447
0.0750	13.3330	1.1	0.34	-0.0035	0.444
0.0741	13.5000	1.1	0.34	-0.0035	0.443
0.0714	14.0000	1.1	0.35	-0.0036	0.442
0.0700	14.2860	1.1	0.35	-0.0036	0.443
0.0690	14.5000	1.1	0.35	-0.0036	0.445
0.0667	15.0000	1.1	0.36	-0.0037	0.447
0.0650	15.3850	1.0	0.36	-0.0037	0.449
0.0625	16.0000	1.0	0.37	-0.0036	0.452
0.0600	16.6670	1.0	0.36	-0.0037	0.456
0.0588	17.0000	1.0	0.35	-0.0037	0.456
0.0556	18.0000	1.0	0.35	-0.0037	0.459
0.0530	18.8680	1.0	0.36	-0.0037	0.458
0.0500	20.0000	1.0	0.36	-0.0037	0.461
0.0455	22.0000	0.9	0.36	-0.0037	0.471
0.0400	25.0000	0.9	0.37	-0.0036	0.477
0.0357	28.0000	0.8	0.39	-0.0036	0.473
0.0340	29.4120	0.7	0.40	-0.0035	0.470
0.0323	31.0000	0.7	0.40	-0.0035	0.466
0.0300	33.3330	0.6	0.41	-0.0035	0.462
0.0294	34.0000	0.6	0.41	-0.0034	0.462

Apéndice B:

Validación de técnicas de simulación numérica del movimiento sísmico del suelo

Tabla B.1. Listado de las modelizaciones disponibles para la realización del ejercicio Benchmark.

Participante	Método	Estructura geológica	Valores de Q	Ondas Incidentes	Movimientos de Entrada	Puntos de cálculo
Institut Cartogràfic de Catalunya (Barcelona)	Shake	AUTH	Real values*	S waves	Ricker 1Hz	60 receivers and strong motion stations
Institut Cartogràfic de Catalunya (Barcelona)	Shake	LGIH	Real values*	S waves	Ricker 1Hz	60 receivers and strong motion stations
Institut Cartogràfic de Catalunya (Barcelona)	Kennet	AUTH	Real values*	S waves	Ricker 1Hz	60 receivers and strong motion stations
Institut Cartogràfic de Catalunya (Barcelona)	Kennet	LGIH	Real values*	S waves	Ricker 1Hz	60 receivers and strong motion stations
Institut Cartogràfic de Catalunya (Barcelona)	Aki-Larner	Simplified	Real values*	S waves	Ricker 1Hz	60 receivers
Institut Cartogràfic de Catalunya (Barcelona)	Shake	AUTH	Real values*	S waves	Ricker 5Hz	60 receivers and strong motion stations
Institut Cartogràfic de Catalunya (Barcelona)	Shake	LGIH	Real values*	S waves	Ricker 5Hz	60 receivers and strong motion stations
Institut Cartogràfic de Catalunya (Barcelona)	Kennet	AUTH	Real values*	S waves	Ricker 5Hz	60 receivers and strong motion stations
Institut Cartogràfic de Catalunya (Barcelona)	Kennet	LGIH	Real values*	S waves	Ricker 5Hz	60 receivers and strong motion stations
Institut Cartogràfic de Catalunya (Barcelona)	Aki-Larner	Simplified	Real values*	S waves	Ricker 5Hz	60 receivers

Institut Cartogràfic de Catalunya (Barcelona)	Shake	AUTH	Real values*	S waves	Arnaia earthquake	Strong Motion Stations
Institut Cartogràfic de Catalunya (Barcelona)	Shake	AUTH	Real values*	S waves	Kozani earthquake at Profitis station	Strong Motion Stations
Comenius University (Bratislava)	Finite Differences	AUTH	Real values*	S waves	Ricker 1Hz	60 receivers and strong motion stations
Comenius University (Bratislava)	Finite Differences	AUTH	Real values*	P waves	Ricker 1Hz	60 receivers and strong motion stations
Comenius University (Bratislava)	Finite Differences	AUTH	High values	S waves	Ricker 1Hz	60 receivers and strong motion stations
Comenius University (Bratislava)	Finite Differences	AUTH	High values	P waves	Ricker 1Hz	60 receivers and strong motion stations
Comenius University (Bratislava)	Finite Differences	LGIH	Real values*	S waves	Ricker 1Hz	60 receivers and strong motion stations
Comenius University (Bratislava)	Finite Differences	LGIH	Real values*	P waves	Ricker 1Hz	60 receivers and strong motion stations
Comenius University (Bratislava)	Finite Differences	AUTH	Real values*	S waves	Ricker 0.3Hz	60 receivers and strong motion stations
Comenius University (Bratislava)	Finite Differences	AUTH	Real values*	P waves	Ricker 0.3Hz	60 receivers and strong motion stations
Comenius University (Bratislava)	Finite Differences	AUTH	High values	S waves	Ricker 0.3Hz	60 receivers and strong motion stations
Comenius University (Bratislava)	Finite Differences	AUTH	High values	P waves	Ricker 0.3Hz	60 receivers and strong motion stations
Comenius University (Bratislava)	Finite Differences	LGIH	Real values*	S waves	Ricker 0.3Hz	60 receivers and strong motion stations

Comenius University (Bratislava)	Finite Differences	LGIH	Real values*	P waves	Ricker 0.3Hz	60 receivers and strong motion stations
Comenius University (Bratislava)	Finite Differences	AUTH	Real values*	S waves	Ricker 3Hz	60 receivers and strong motion stations
Comenius University (Bratislava)	Finite Differences	AUTH	Real values*	P waves	Ricker 3Hz	60 receivers and strong motion stations
Comenius University (Bratislava)	Finite Differences	AUTH	High values	S waves	Ricker 3Hz	60 receivers and strong motion stations
Comenius University (Bratislava)	Finite Differences	AUTH	High values	P waves	Ricker 3Hz	60 receivers and strong motion stations
Comenius University (Bratislava)	Finite Differences	LGIH	Real values*	S waves	Ricker 3Hz	60 receivers and strong motion stations
Comenius University (Bratislava)	Finite Differences	LGIH	Real values*	P waves	Ricker 3Hz	60 receivers and strong motion stations
Comenius University (Bratislava)	Finite Differences	AUTH	Real values*	S waves	Arnaia earthquake	60 receivers and strong motion stations
Comenius University (Bratislava)	Finite Differences	AUTH	High values	S waves	Arnaia earthquake	60 receivers and strong motion stations
Comenius University (Bratislava)	Finite Differences	LGIH	Real values*	S waves	Arnaia earthquake	60 receivers and strong motion stations
Comenius University (Bratislava)	Finite Differences	AUTH	Real values*	S waves	Kozani earthquake at Profitis station	60 receivers and strong motion stations

Comenius University (Bratislava)	Finite Differences	AUTH	High values	S waves	Kozani earthquake at Profitis station	60 receivers and strong motion stations
Comenius University (Bratislava)	Finite Differences	LGIH	Real values*	S waves	Kozani earthquake at Profitis station	60 receivers and strong motion stations
Comenius University (Bratislava)	Finite Differences	AUTH	Real values*	S waves	June 24, 1994	60 receivers and strong motion stations
Comenius University (Bratislava)	Finite Differences	AUTH	High values	S waves	June 25, 1994	60 receivers and strong motion stations
Comenius University (Bratislava)	Finite Differences	LGIH	Real values*	S waves	June 26, 1994	60 receivers and strong motion stations
Joseph Fourier University (Grenoble)	Aki-Larner	AUTH	Real values*	S waves	Ricker 1Hz	60 receivers
Joseph Fourier University (Grenoble)	Aki-Larner	LGIH	Real values*	S waves	Ricker 1Hz	60 receivers
Joseph Fourier University (Grenoble)	Kennet	AUTH	Real values*	S waves	Arnaia earthquake	60 receivers
Joseph Fourier University (Grenoble)	Kennet	AUTH	Real values*	S waves	Kozani earthquake at Profitis station	60 receivers
Aristotle University of Thessaloniki	Shake	AUTH	Real values*	S waves	Ricker 1Hz	Strong Motion Stations

Aristotle University of Thessaloniki	Shake	LGIH	Mean values	S waves	Ricker 1Hz	Strong Motion Stations
Aristotle University of Thessaloniki	Shake	AUTH	Real values*	S waves	Ricker 5Hz	Strong Motion Stations
Aristotle University of Thessaloniki	Shake	LGIH	Mean values	S waves	Ricker 5Hz	Strong Motion Stations
Aristotle University of Thessaloniki	Shake	AUTH	Real values*	S waves	Kozani earthquake at Kozani station	Strong Motion Stations
Aristotle University of Thessaloniki	Shake	LGIH	Mean values	S waves	Kozani earthquake at Kozani station	Strong Motion Stations
Aristotle University of Thessaloniki	Shake	AUTH	Real values*	S waves	Ricker 1Hz scaled to 0.2g	Strong Motion Stations
Aristotle University of Thessaloniki	Shake	LGIH	Mean values	S waves	Ricker 1Hz scaled to 0.2g	Strong Motion Stations
Aristotle University of Thessaloniki	Shake	AUTH	Real values*	S waves	Ricker 5Hz scaled to 0.2g	Strong Motion Stations
Aristotle University of Thessaloniki	Shake	LGIH	Mean values	S waves	Ricker 5Hz scaled to 0.2g	Strong Motion Stations
Ecole Centrale de Paris (Chatenay-Malabry)	Cyberquake	AUTH	Real values*	S waves	Ricker 1Hz scaled to 0.2g	TST (Test Site)

Ecole Centrale de Paris (Chatenay-Malabry)	Cyberquake	AUTH	Real values*	S waves	Ricker 5Hz scaled to 0.2g	TST (Test Site)
Ecole Centrale de Paris (Chatenay-Malabry)	Cyberquake	AUTH	Real values*	S waves	Kozani earthquake at Kozani station scaled to 0.2g	TST (Test Site)
Ecole Centrale de Paris (Chatenay-Malabry)	Cyberquake	AUTH	Real values*	S waves	Kozani earthquake at Profitis station scaled to 0.2g	TST (Test Site)
Charles University (Praha)	Finite Differences	LGIH	Real values*	S waves	Ricker 4Hz	60 receivers
Ecole Centrale de Paris (Paris)	Boundary Elements	LGIH	Real values*	S waves	Arnaia earthquake	60 receivers and strong motion stations
Ecole Centrale de Paris (Paris)	Boundary Elements	LGIH	Real values*	S waves	June 24, 1994	60 receivers and strong motion stations
Ecole Centrale de Paris (Paris)	Boundary Elements	LGIH	Real values*	S waves	Ricker 1Hz	60 receivers and strong motion stations
Ecole Centrale de Paris (Paris)	Boundary Elements	LGIH	Real values*	S waves	Ricker 3Hz	60 receivers and strong motion stations
Ecole Centrale de Paris (Paris)	Boundary Elements	LGIH	Real values*	S waves	Ricker 5Hz	60 receivers and strong motion stations
**valores propuestos para el valle tras la investigación geofísica en la zona en previos proyectos. ** cálculos disponibles sólo para los puntos donde se sitúan estaciones acelerométricas.*					Número de Archivos ~	**9000**

Apéndice C:

Modelización sísmica 2D en el valle pirenaico de la Cerdanya

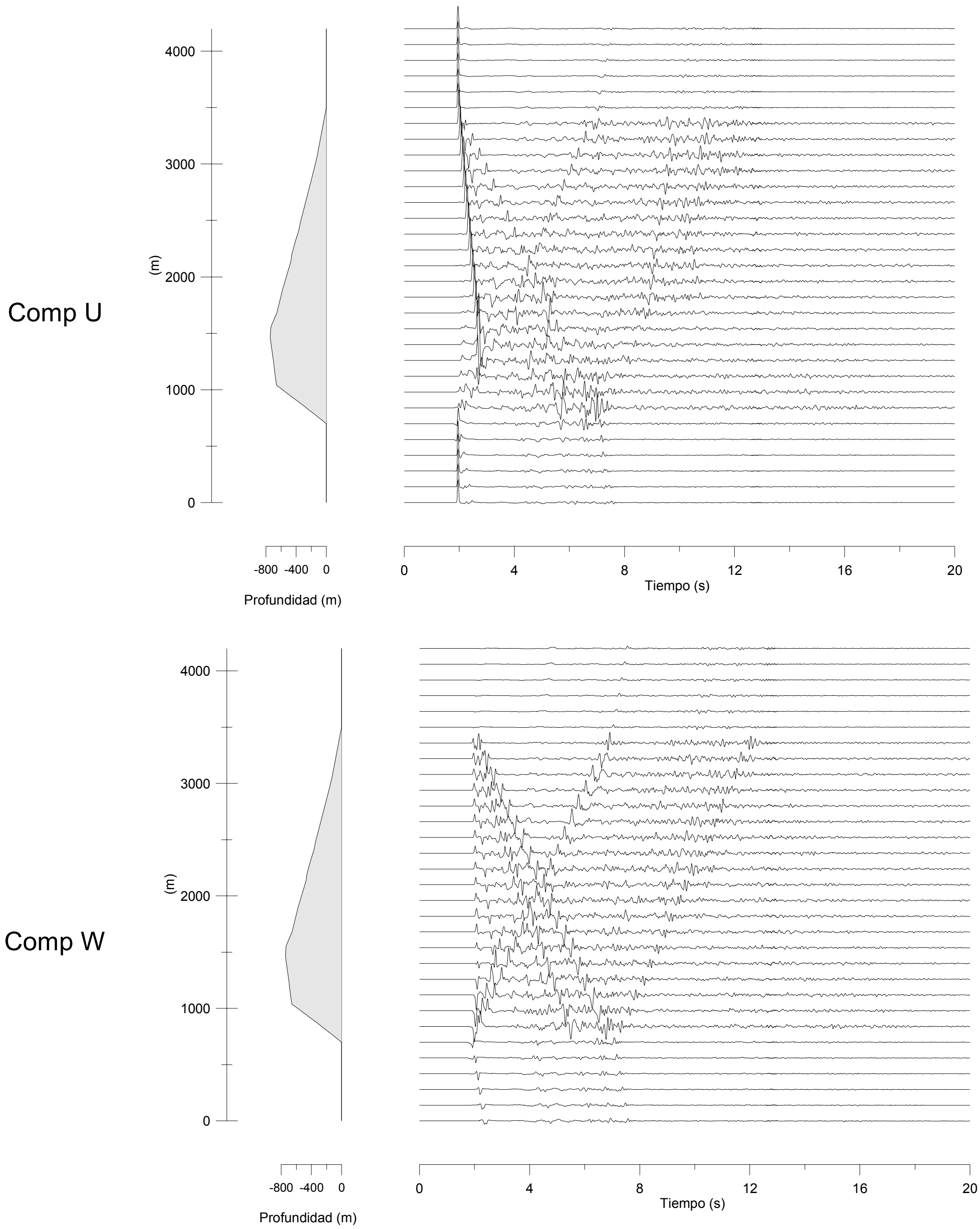


Figura C.1. Registros sísmicos temporales de la componente U y W simulados utilizando el Modelo 1 de estructura y materiales elásticos. La señal está escalada en amplitud por 100.

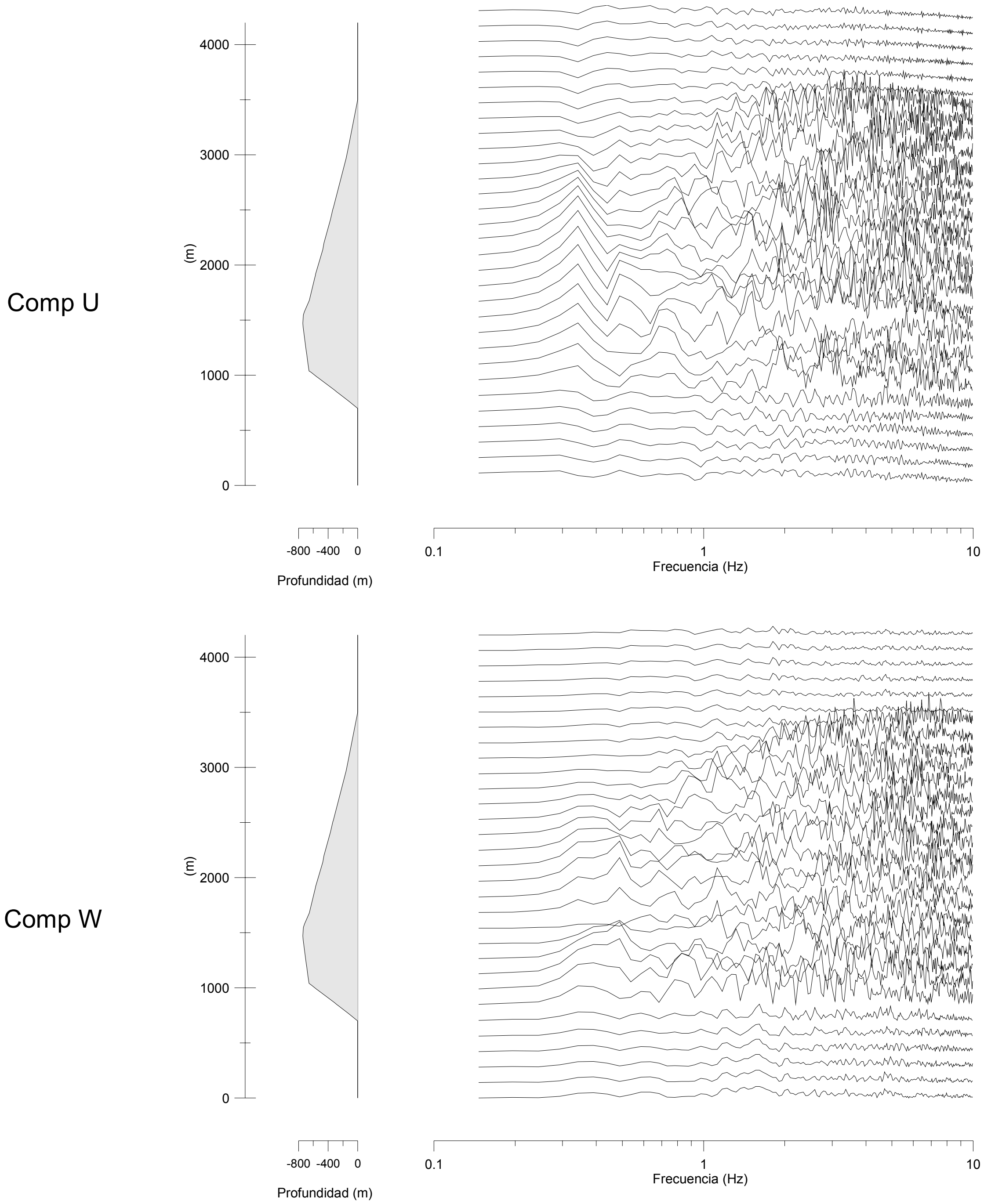


Figura C.2. Espectro de la componente U y W simulados utilizando el Modelo 1 de estructura y materiales elásticos. La señal está escalada en amplitud por 1000.

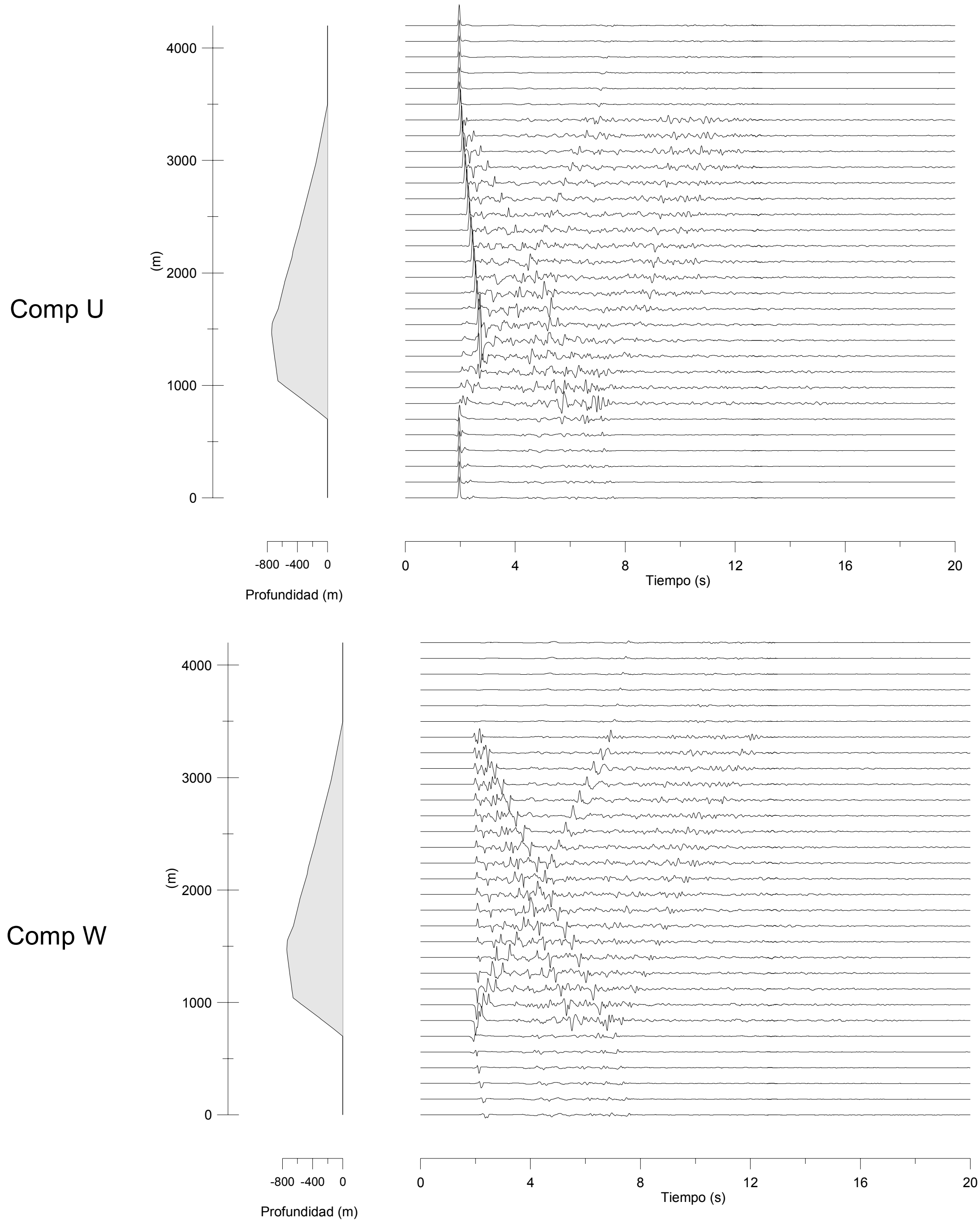


Figura C.3. Registros sísmicos temporales de la componente U y W simulados utilizando el Modelo 1 de estructura y materiales ligeramente viscoelásticos. La señal está escalada en amplitud por 100.

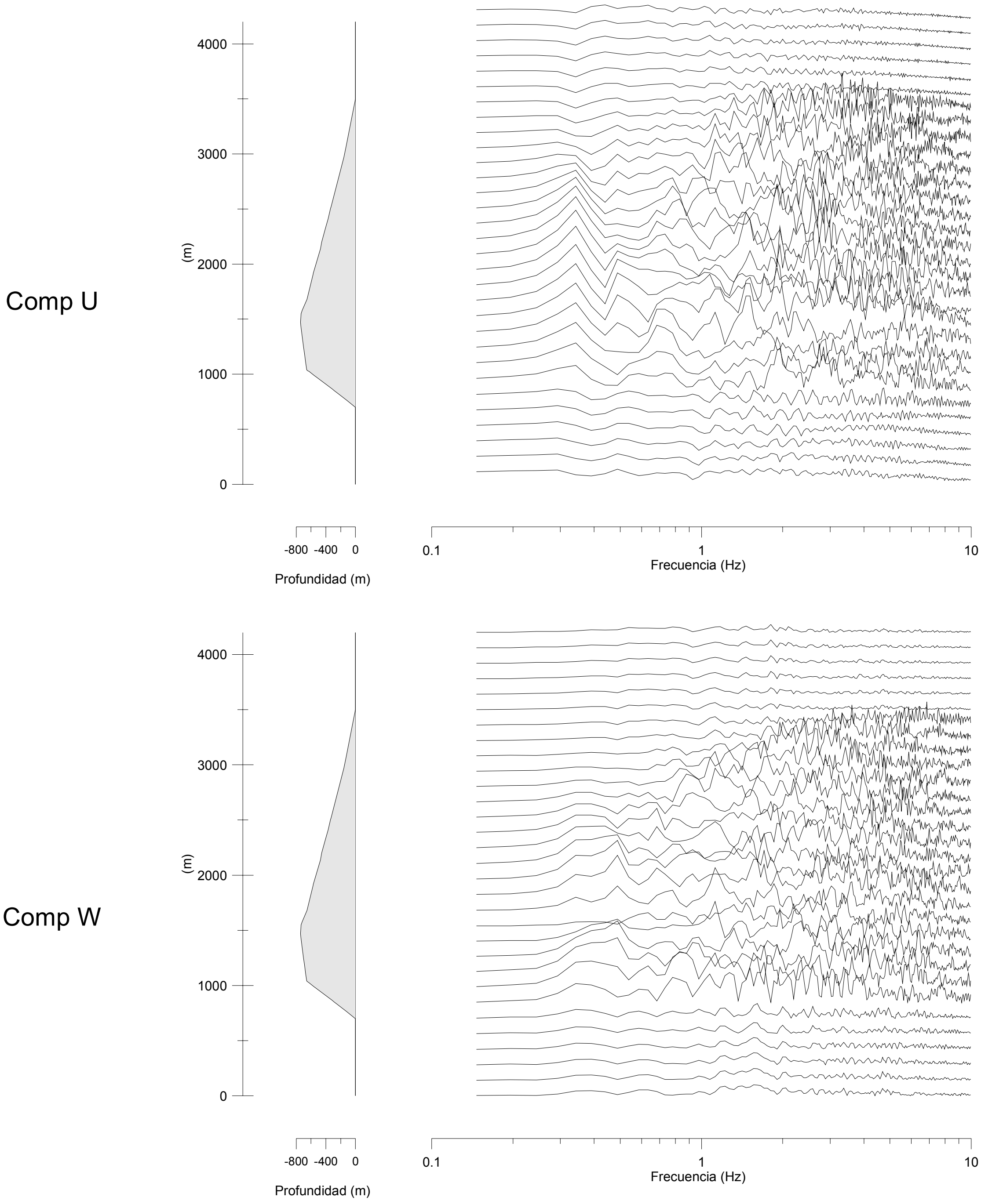


Figura C.4. Espectro de la componente U y W simulados utilizando el Modelo 1 de estructura y materiales ligeramente viscoelásticos. La señal está escalada en amplitud por 1000.

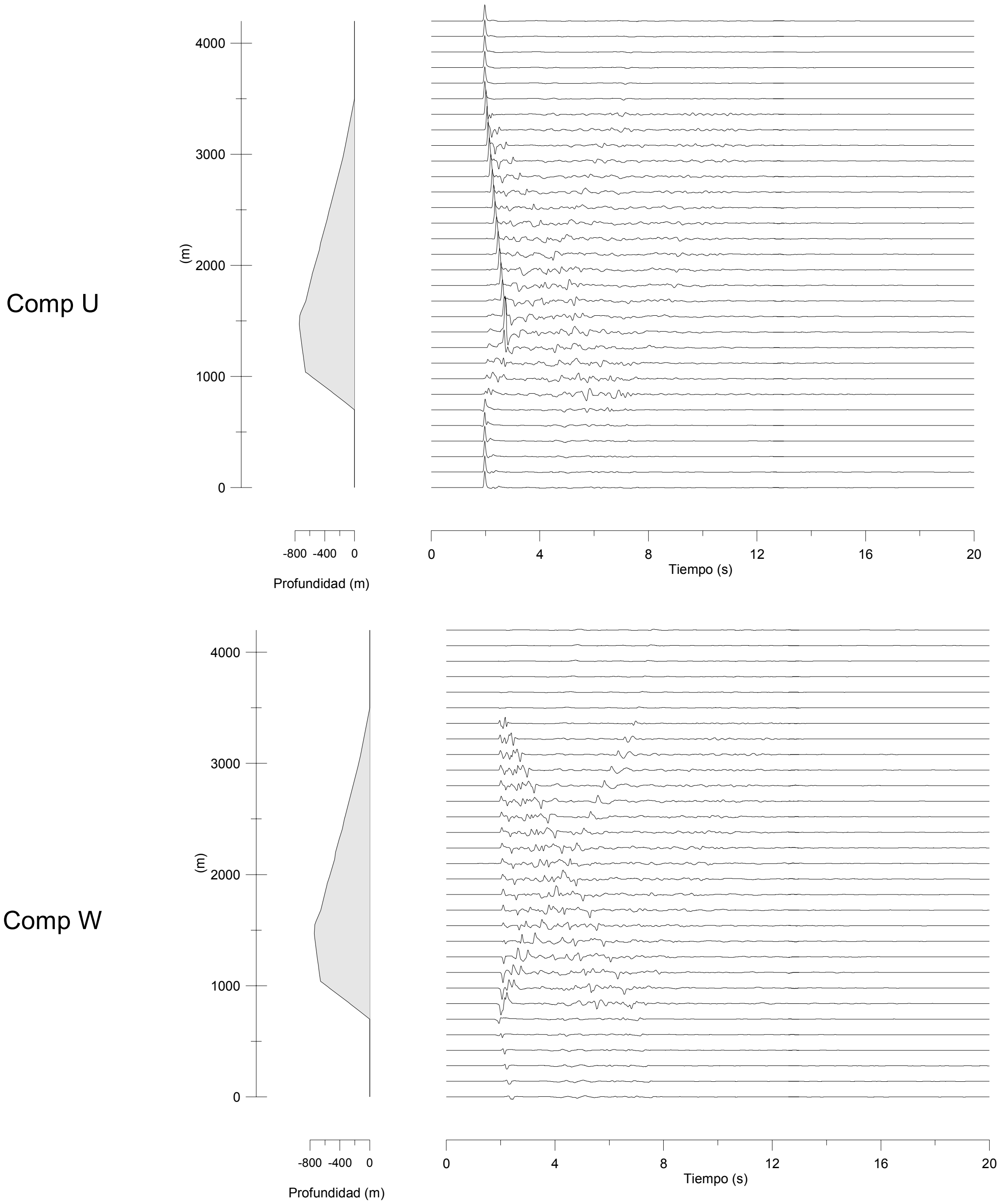
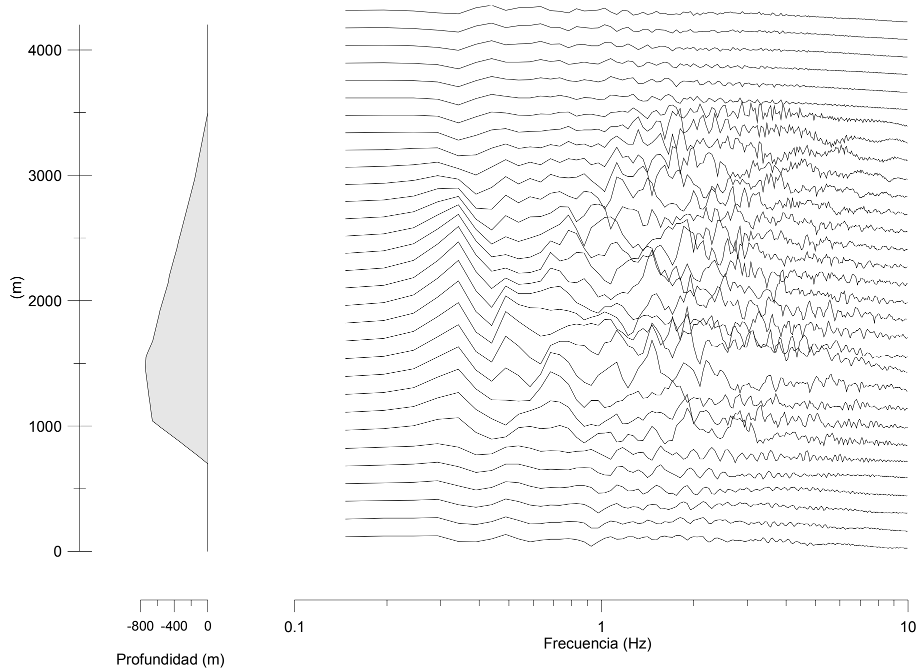


Figura C.5. Registros sísmicos temporales de la componente U y W simulados utilizando el Modelo 1 de estructura y materiales altamente viscoelásticos. La señal está escalada en amplitud por 100.

Comp U



Comp W

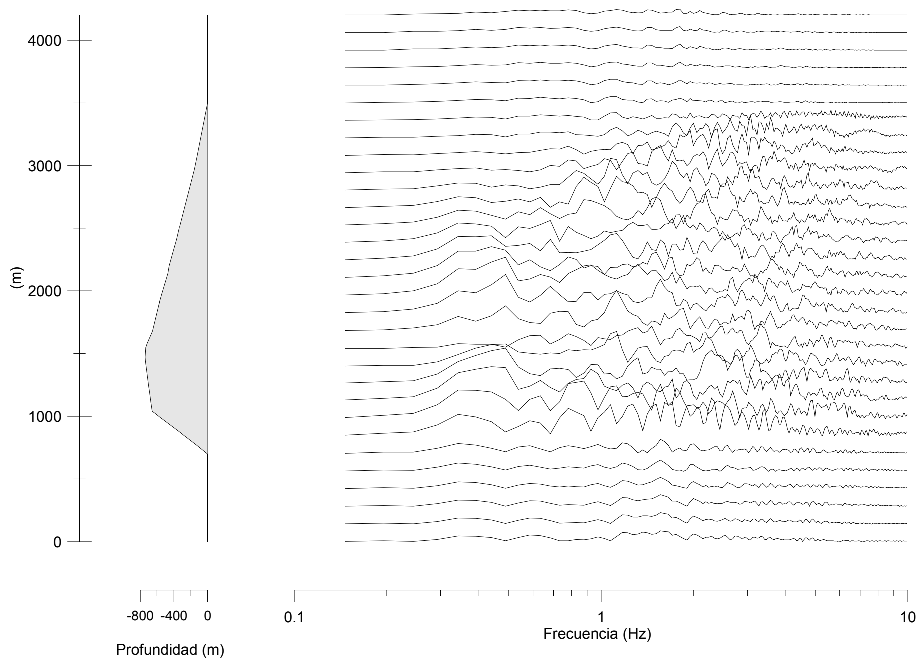


Figura C.6. Espectro de la componente U y W simulados utilizando el Modelo 1 de estructura y materiales altamente viscoelásticos. La señal está escalada en amplitud por 1000.

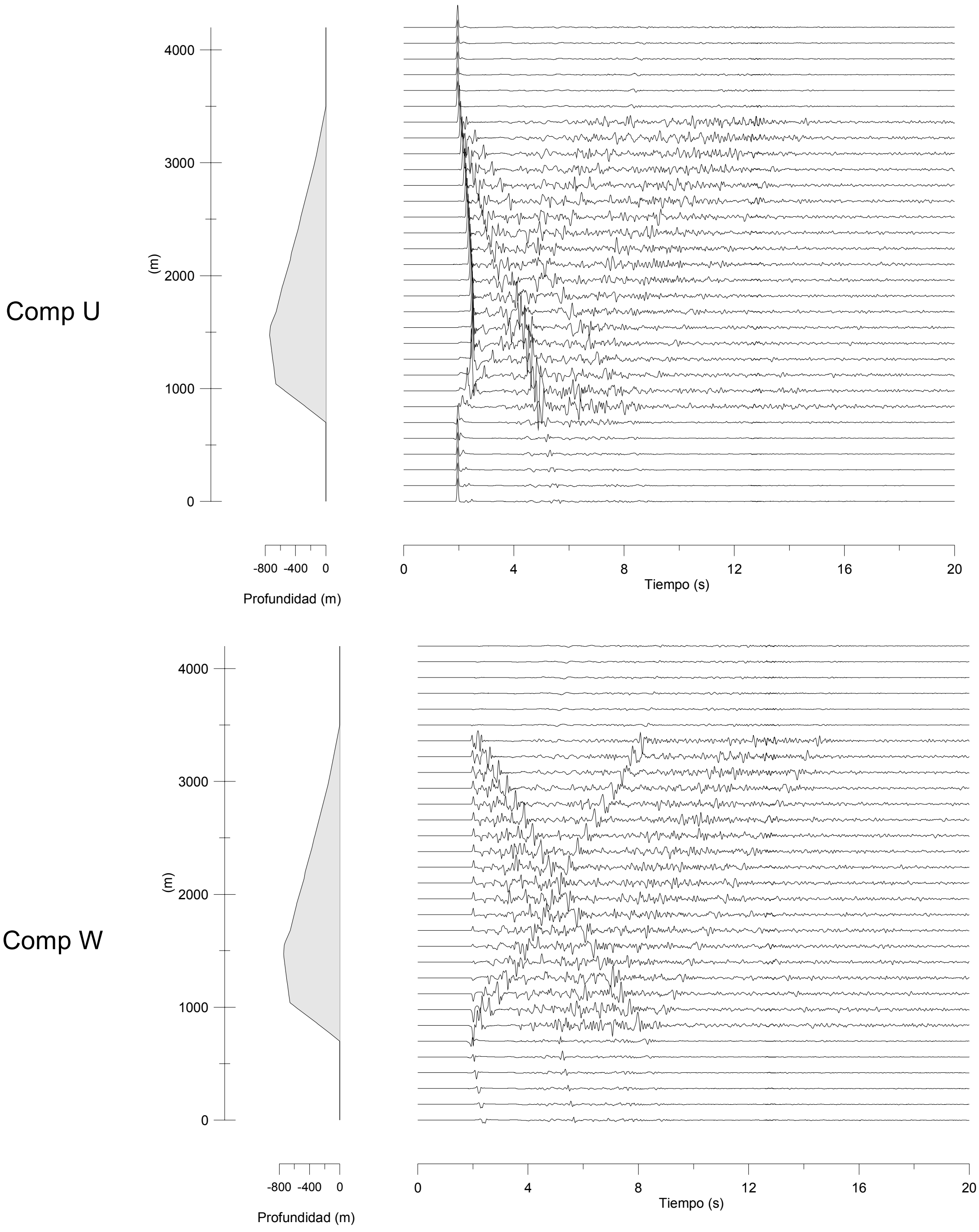


Figura C.7. Registros sísmicos temporales de la componente U y W simulados utilizando el Modelo 2 de estructura y materiales elásticos. La señal está escalada en amplitud por 100.

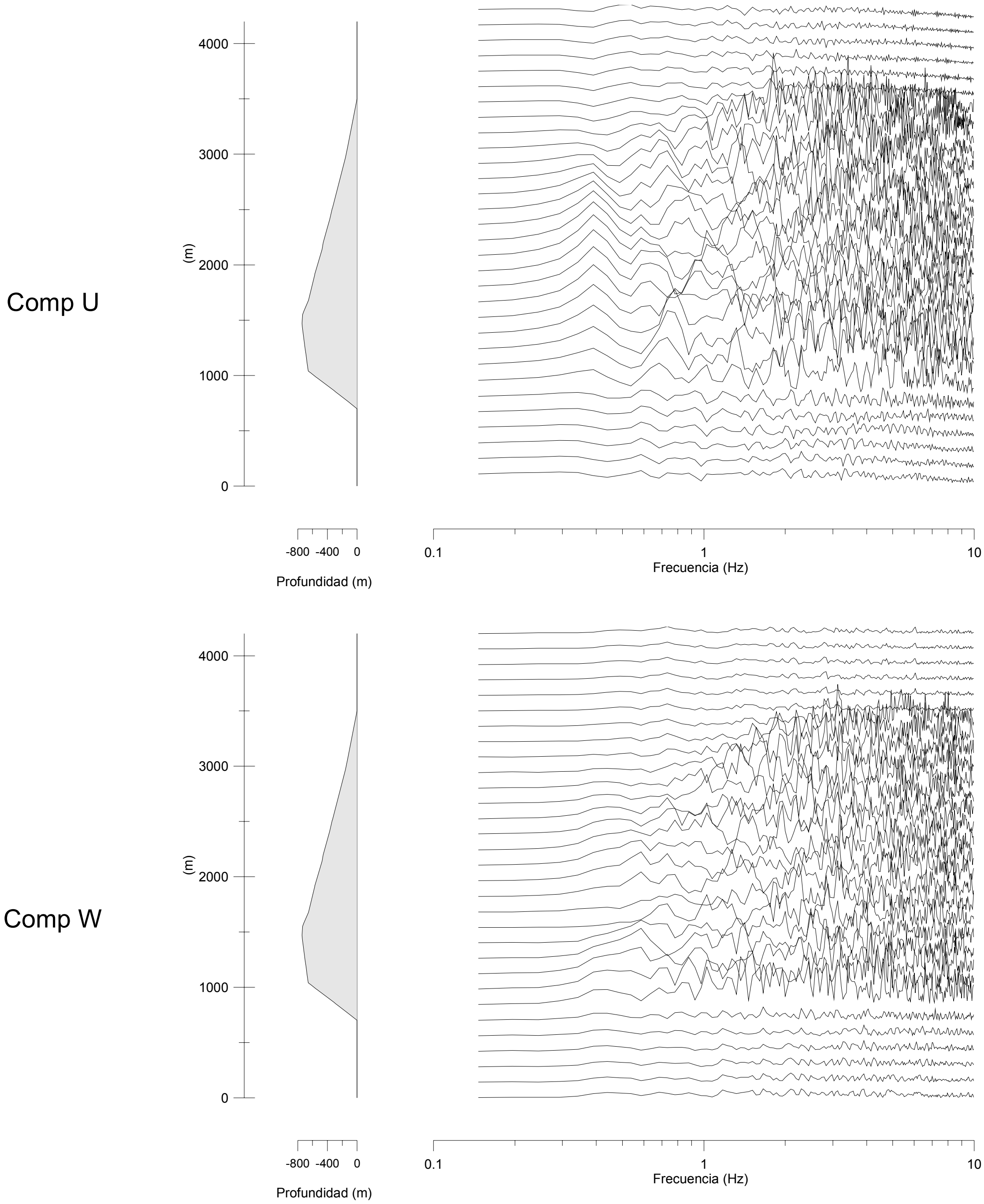


Figura C.8. Espectro de la componente U y W simulados utilizando el Modelo 2 de estructura y materiales elásticos. La señal está escalada en amplitud por 1000.

Comp U

Comp W

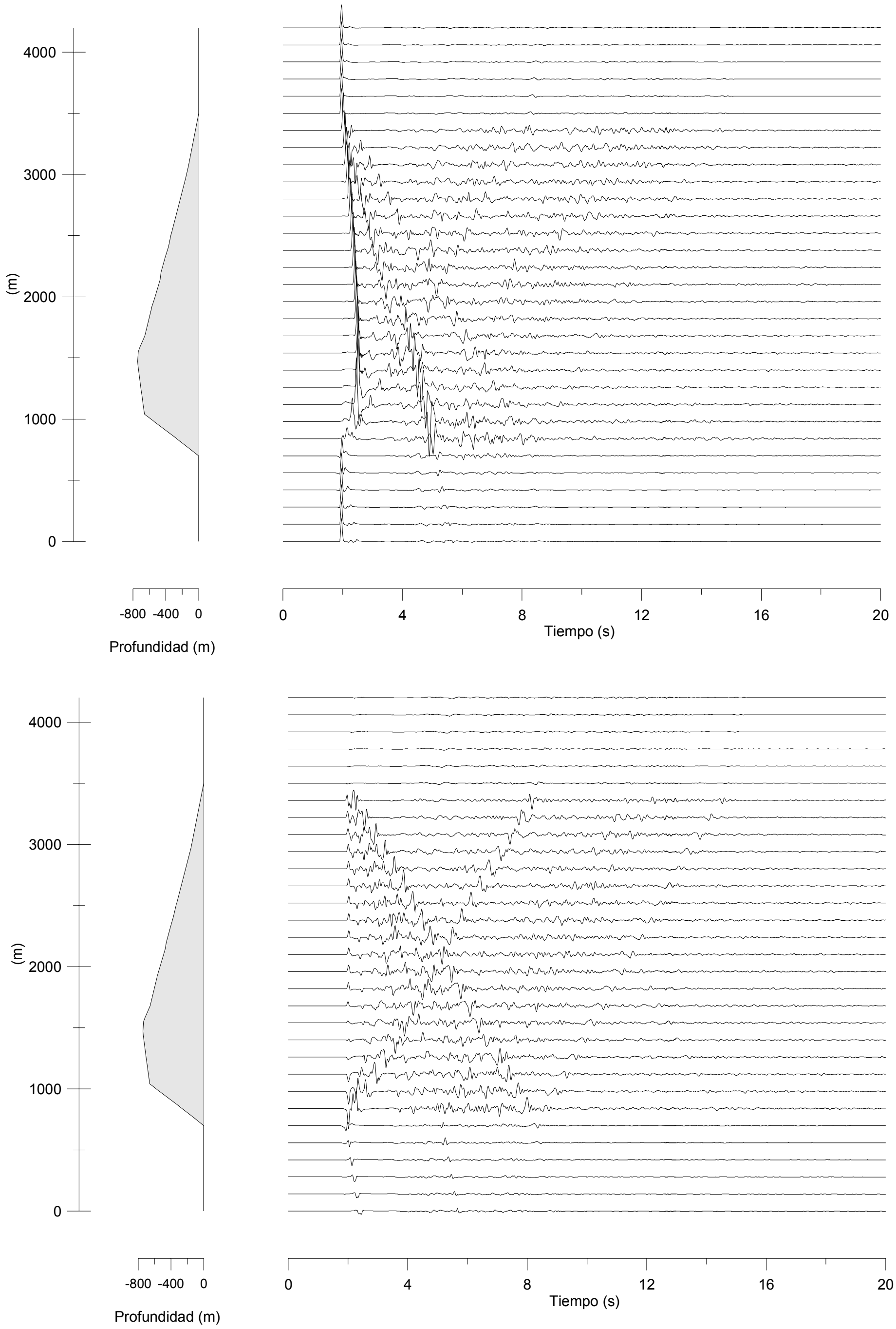


Figura C.9. Registros sísmicos temporales de la componente U y W simulados utilizando el Modelo 2 de estructura y materiales ligeramente viscoelásticos. La señal está escalada en amplitud por 100.

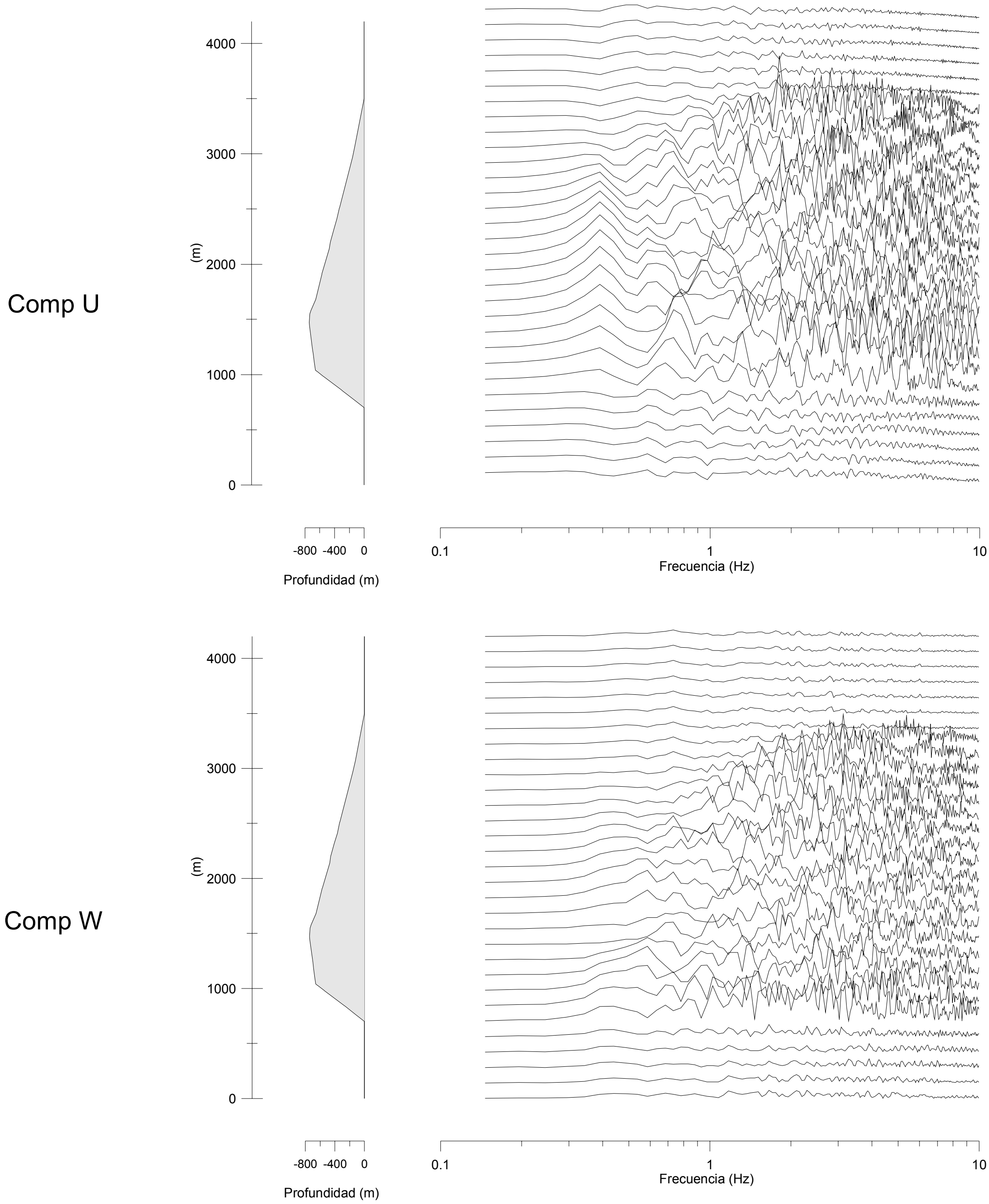
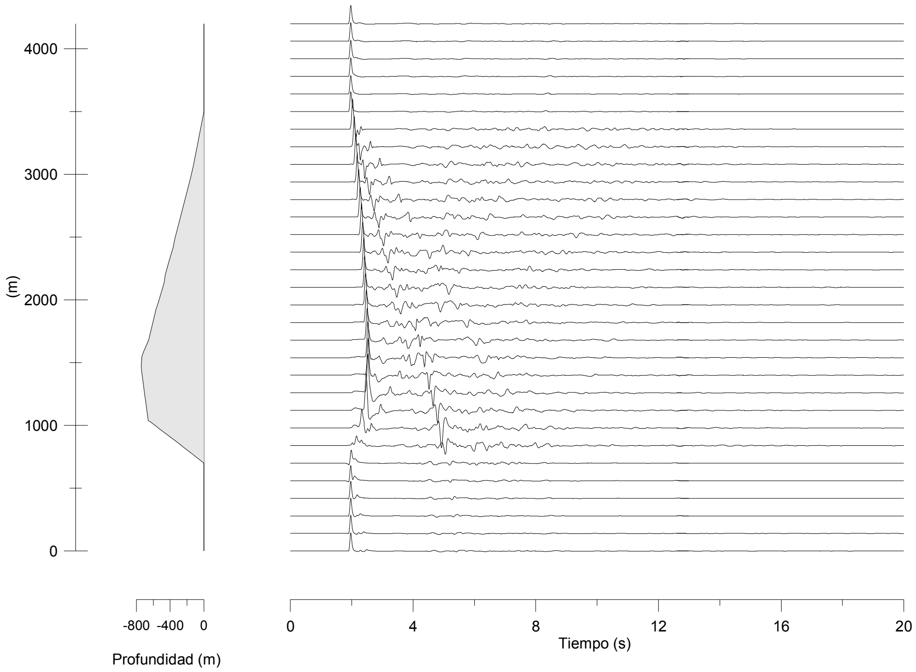


Figura C.10. Espectro de la componente U y W simulados utilizando el Modelo 2 de estructura y materiales ligeramente viscoelásticos. La señal está escalada en amplitud por 1000.

Comp U



Comp W

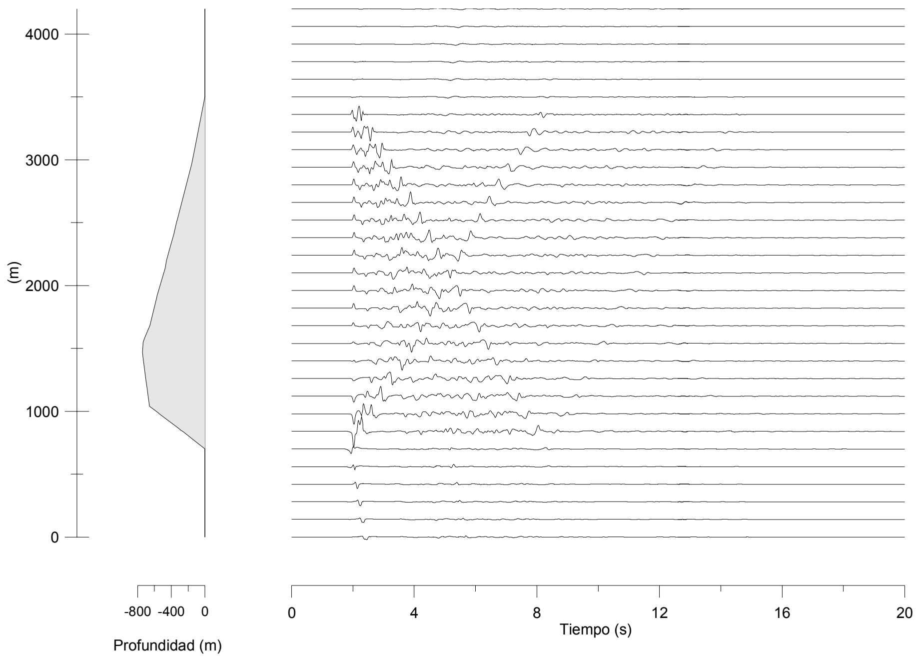
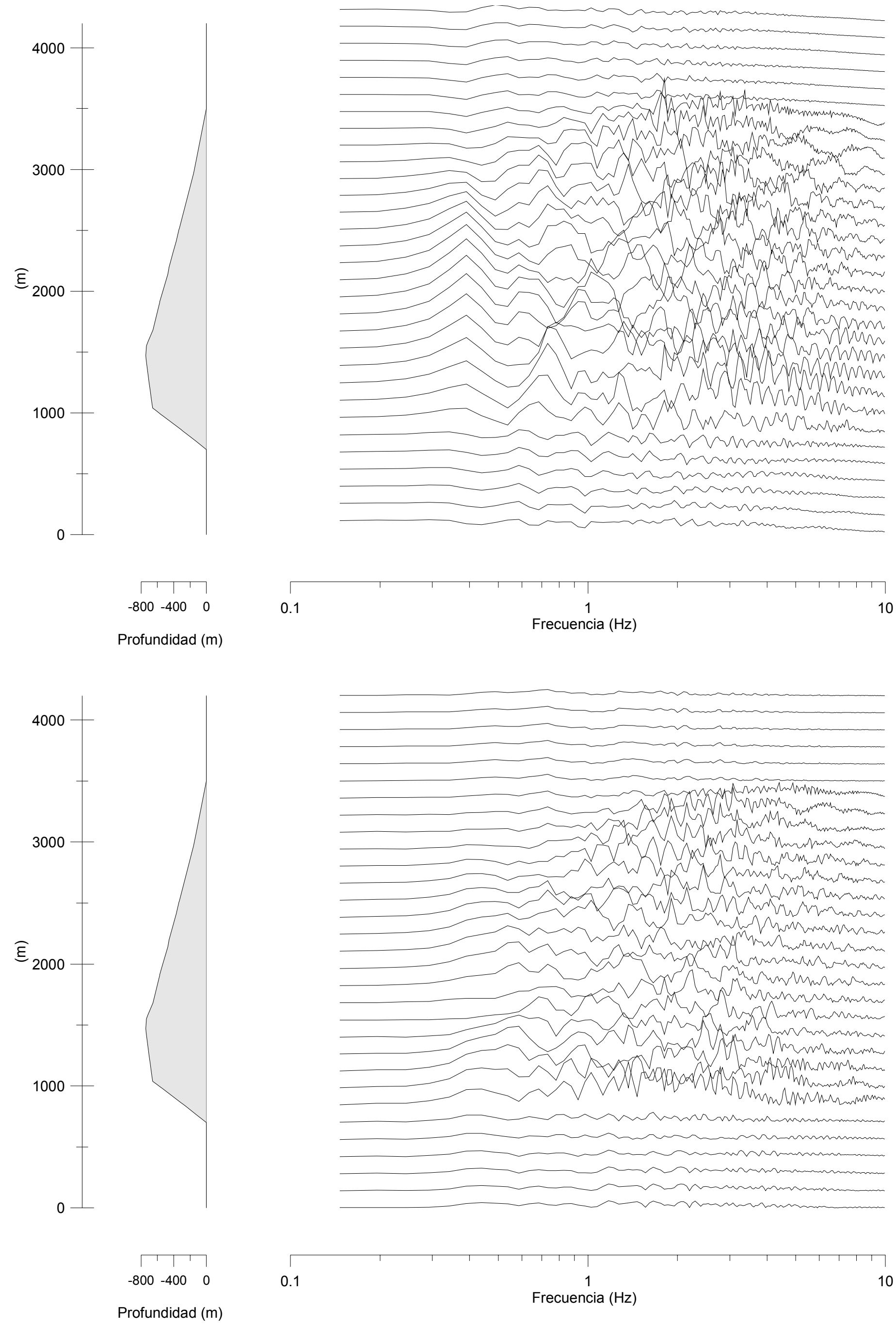


Figura C.11. Registros sísmicos temporales de la componente U y W simulados utilizando el Modelo 1 de estructura y materiales altamente viscoelásticos. La señal está escalada en amplitud por 100.

Comp U



Comp W

Figura C.12. Espectro de la componente U y W simulados utilizando el Modelo 2 de estructura y materiales altamente viscoelásticos. La señal está escalada en amplitud por 1000.

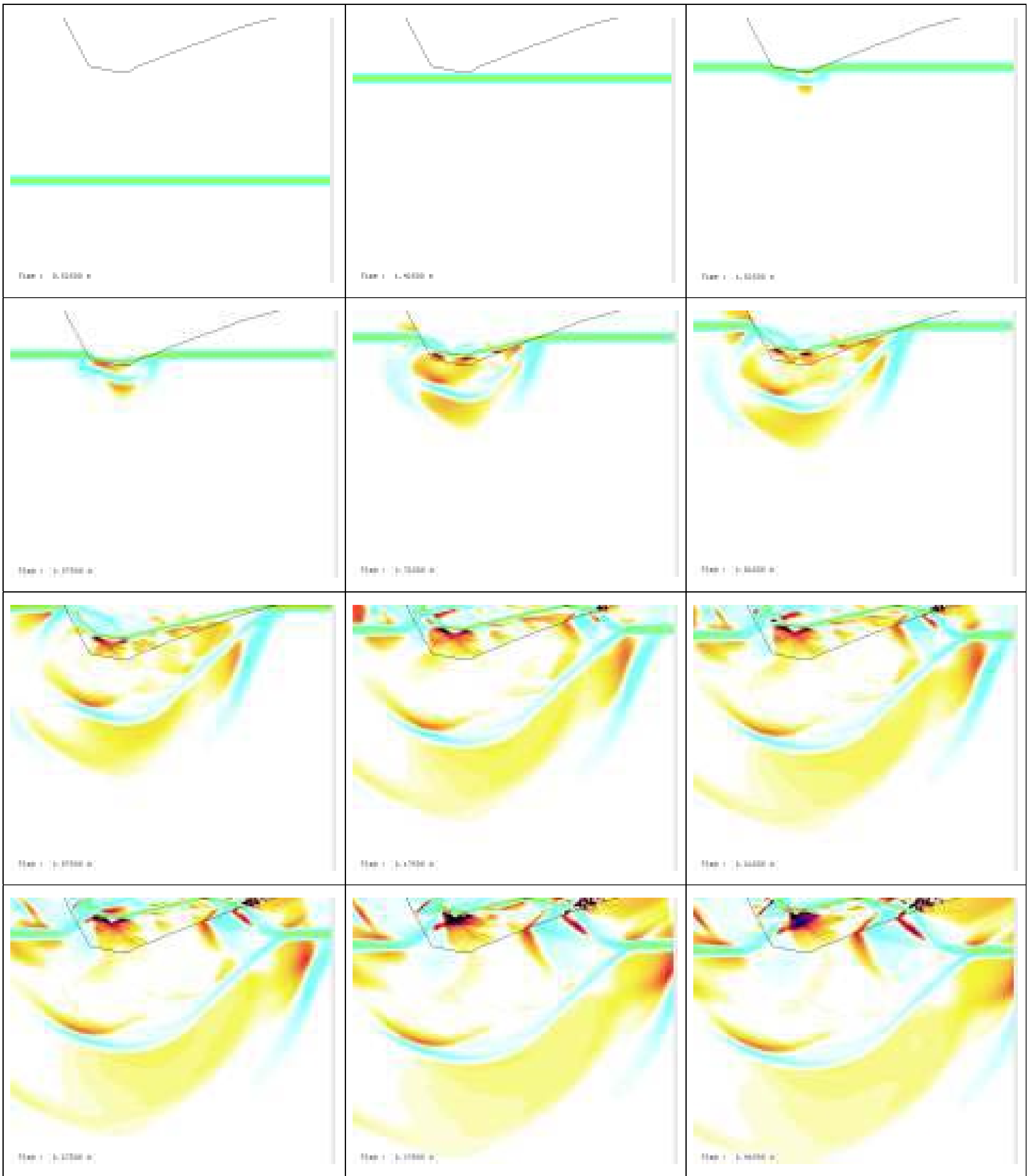


Figura C.13. Fotogramas de la evolución del frente de ondas planas propagándose en el valle. (cont.).

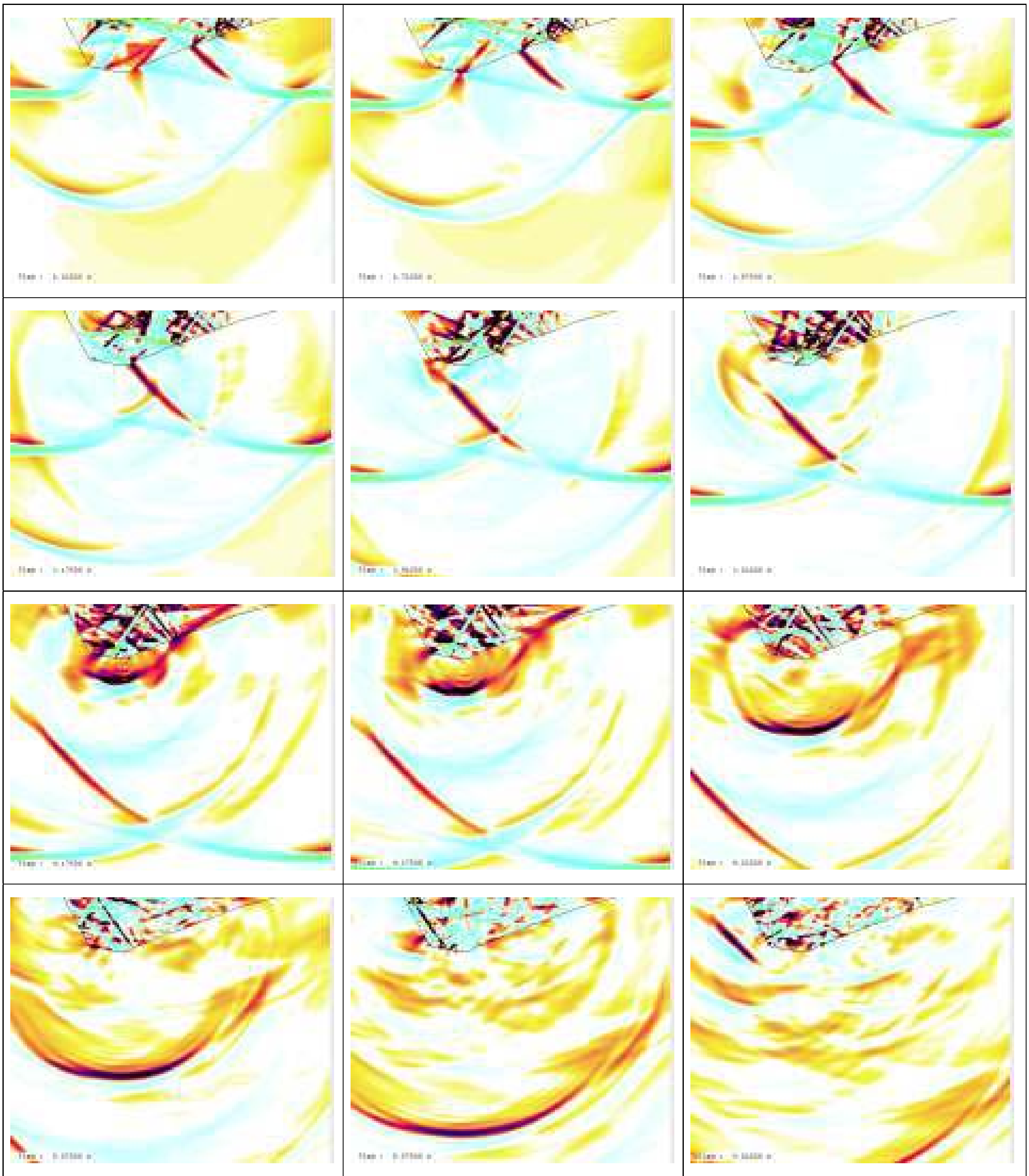


Figura C.14. Fotogramas de la evolución del frente de ondas planas propagándose en el valle.

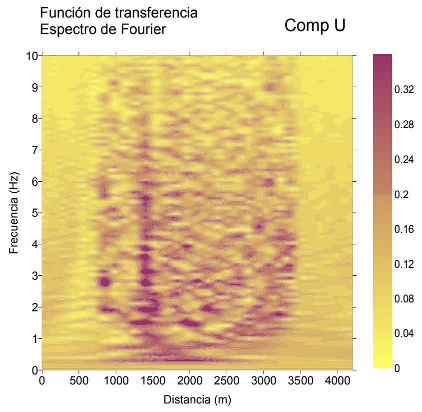
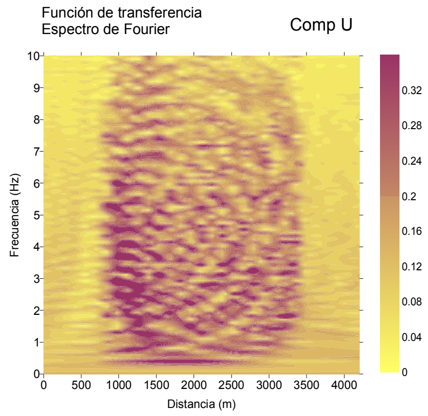
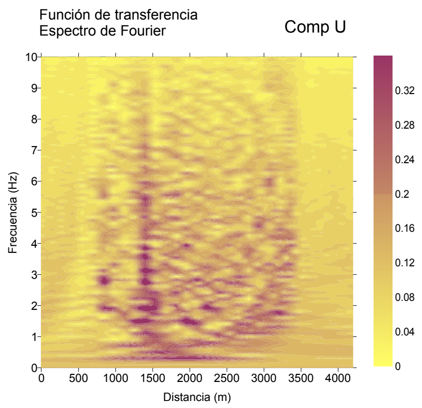
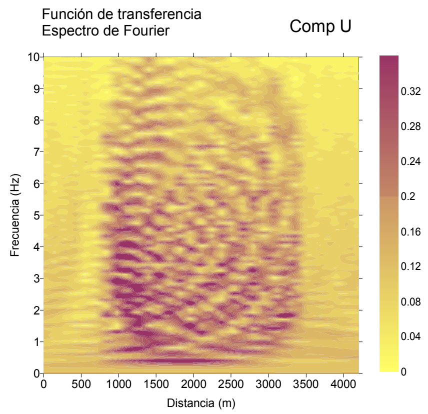
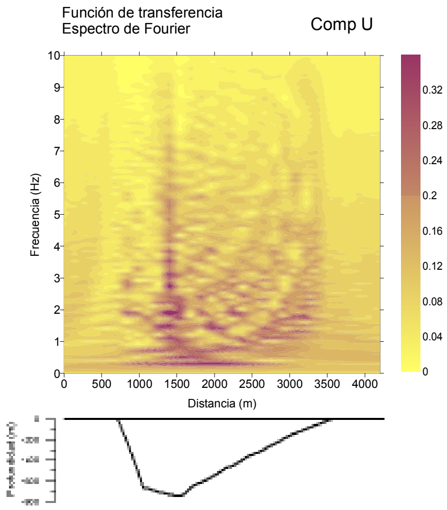
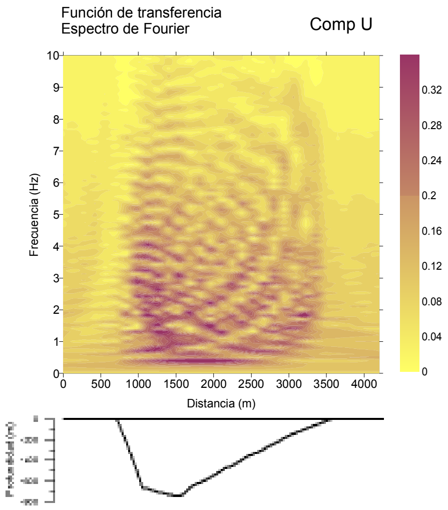
	Modelo 1	Modelo 2
Elastic		
Qp=400, Qs=200		
Qp=100, Qs=50		

Figura C.15. Espectros de la componente U simulados para todos los casos.

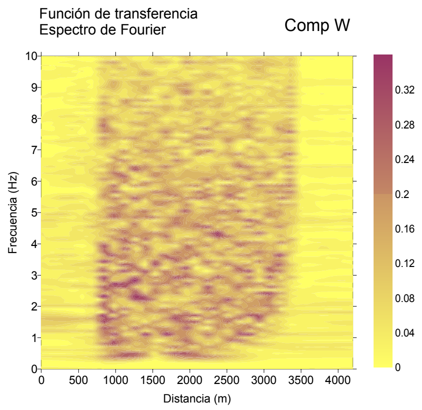
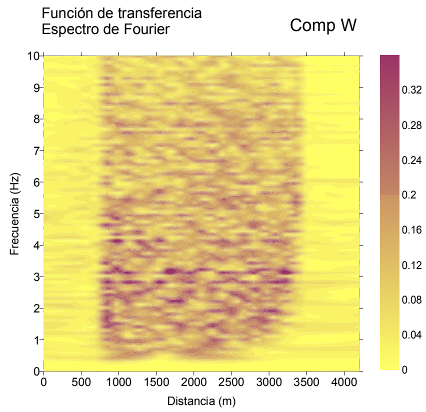
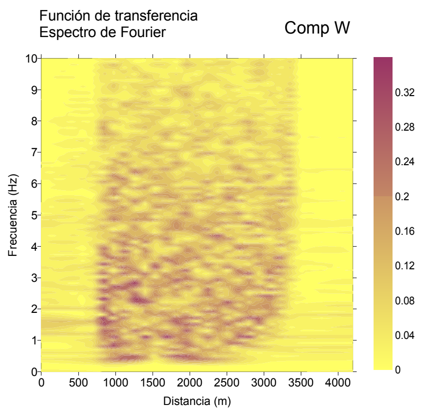
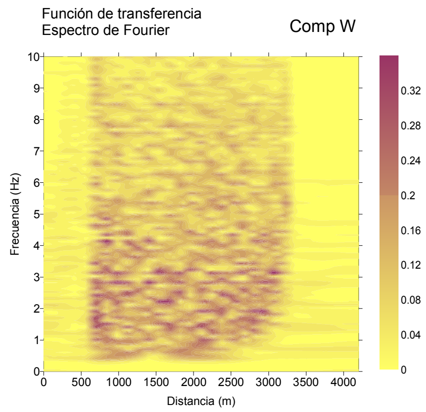
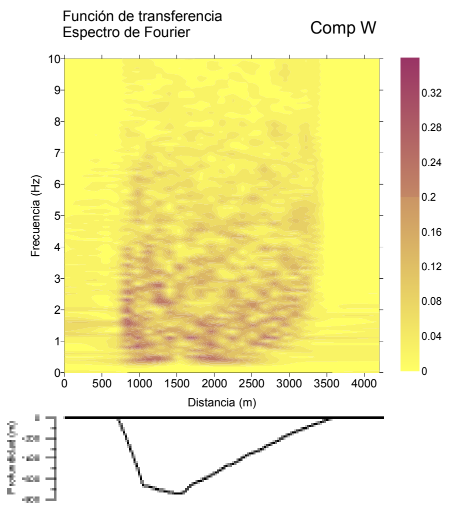
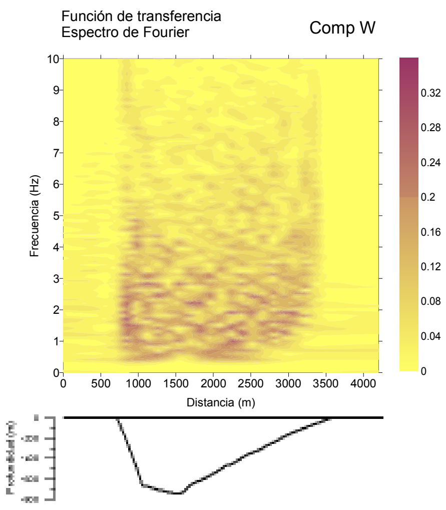
	Modelo 1	Modelo 2
Elastic		
Qp=400, Qs=200		
Qp=100, Qs=50		

Figura C.16. Espectros de la componente W simulados para todos los casos.